Feilden's Magazine

THE WORLD'S RECORD OF

Industrial Progress.

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ANNOUNCEMENTS.

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1900 and Onwards!

"Naught shall make us rue
If England to itself do rest but true!"

OUR great national poet's historic lines recur to us to-day with tenfold force. Great Britain is now passing through a crisis in her history—a crisis as acute and real as any which has ever occurred since the days when we first became a nation, and through which over and over again we have come out with flying colours. We have no fear of the ultimate result of the present trouble and anxiety with which the country is now involved. We shall pull through right enough, no matter what the cost may be or what sacrifices we may have to make. But whilst the Transvaal War has shown that the fighting abilities, the indomitable courage, and the noble heroism of the British soldier is what it ever was, it has proved a few other things besides, and provided a number of object-lessons which must be taken to heart by the people of this country and acted upon earnestly and seriously if we are to retain our national prestige and our lead of the world's trade. Do not let there be any "absent-minded beggars" among us: we need all our memories, all our wits, all our resources, all our ingenuity.

Unquestionably this struggle has, first and foremost, demonstrated that war is more than ever a science, and that the successful nation in any war of the future will be the one which does not so much rely upon the courage of its troops—no matter how essential a factor that may be—as upon the employment of the very latest and best appliances of scientific research, combined with the craft and skill of the engineer and manufacturer. Not merely Britain, but the whole civilized world, has stood amazed at the picture of the greatest and most powerful nation on earth being held in check, nay, and we say it without any want of patriotism, being temporarily beaten by "a mere handful of farmers," who have foreseen what would be required, and have utilized their available resources to the best advantage.

With the first issue of FEILDEN'S MAGAZINE, we published a leading article, entitled "Lest we forget," in which we drew attention to the shortcomings of a large number of the manufacturers of this country. We deprecated the slow, conservative methods which governed many firms' actions, causing them to rely upon worn-out systems and obsolete machinery. We took exception to the retention of the trading methods of our grandfathers, good enough in their day, but useless at the end of the nineteenth century when the conditions of things have so materially and radically altered. We drove home the Latin maxim, *Tempora mutantur et nos mutamur in illis* with all the force we could command, and we strongly urged an assimilation into our trading and manufacturing methods of the tactics adopted by some of the more modern commercial nations, especially the United States, showing as clearly as we could what our rivals had gained, and were gaining, by their constantly putting into practice fresh ideas, new labour-saving devices, more tactful methods of trading, and by other means. We have since persevered in the programme we set ourselves out to attain, and the great encouragement and support we have received has proved that we are on the right track. The war in which the Empire is at present embroiled re-opens the question, or rather intensifies the importance of keeping it alive, with tenfold earnestness, as, when the British flag is hoisted at Pretoria, a new era of trading development will be opened out.

But we must not wait until that time to move. Apart altogether from the vexed question of quick-firing and long-range guns, for which the home authorities are responsible and have to answer to the nation, do our engineers and manufacturers realise that even if the whole of the Transvaal and Orange Free State become British possessions the vast possibilities of our trade with South Africa are in jeopardy. It is a significant fact that representative American and German firms, with that

sagacity, foresight, and push which characterise their commercial dealings, have at the present moment a number of agents in Natal absolutely measuring up all damage being done to bridges, railways, towns, &c., and are actually now making missing or damaged parts *for delivery on the spot as soon as the war is over.* We have the best authority for making this statement. We know of no British firms who are acting in like manner. If there are we should be glad to hear from them.

With our unlimited wealth, our boundless resources, our patriotism and world-famed perseverance and long-headedness no nation on earth is better or so well equipped to face difficult situations as we are, but we cannot afford to rely on our prestige and to be powerfully apathetic —letting chances go by. We must take time by the forelock, and not allow ourselves to be led into the error that the vastly increasing trade of the Transvaal will come to us as a matter of course on the termination of this war. The most strenuous and sagacious efforts on the part of our manufacturers and traders are required to retain and expand it.

A new condition of things is arising, and will prevail. It may not be generally known that out of £16,682,438 worth of goods which South Africa imported during 1898, no less than £11,503,771 worth was supplied by Great Britain, and £923,469 worth went from our Colonies, making the total proportion from the Empire 74½ per cent. Of these £3,130,075 worth went to the Transvaal alone, and though we have not the exact figures for the Orange Free State they could not have been far short. With such a hold as this, what cannot we do when our flag floats over South Africa from the Cape to the Zambesi? British statesmen, British manufacturers, British traders, and British men of business the world over, must look to this. The magnificent loyalty of our Colonies, exemplified so eloquently in the present struggle, will form but a still closer link which should inseparably bind the Empire into a trading community the like of which the world has never seen before—sufficient to sweep every opposition aside. We cannot hope to secure all the trade of the world, nor do economic conditions demand or expect it; but we can, and must, retain what we have fought and bled for—we must at least hold and conserve our own.

As to the present trouble, we have but to recall the immortal words of a very illustrious American — Emerson — who, when he visited England in 1847, at a time of great pressure and commercial distress, said, in speaking at Manchester:

> "I see her not dispirited, not weak, but well remembering that she has seen dark days before; indeed, with a kind of instinct that she sees a little better in a cloudy day, and that in a storm of battle and calamity she has a secret vigour and a pulse like a cannon. I see her in her old age, not decrepit, but young, and still daring to believe in her power of endurance and expansion. Seeing this, I say, 'All hail! mother of heroes, with strength still equal to the time; still wise to entertain and swift to execute the policy which the mind and heart of man requires in the present hour, and thus only hospitable to the foreigner, and truly a home to the thoughtful and generous who are born in the soil.' So be it. So let it be. If it be not so, if the courage of England goes with the chances of a commercial crisis, I will go back to the capes of Massachusetts, and my own Indian stream, and say to my countrymen: 'The old race are all gone, and the elasticity and hope of mankind must henceforth remain on the Alleghany ranges, or nowhere.'"

The future is in the hands of the present and rising generations, and we have no fear but that England will be true to her traditions.

1899.—A Survey.

THE year 1899 will be recorded as a memorable year in the annals of British history. It must necessarily be notable on account of circumstances which for the most part have never before been associated with the British Empire.

Dismissing for the moment matters of current war interest, we feel inclined to place the most weight in regard to this country on the great change in opinion which has made, and is now making itself manifest in respect to manufacturing conditions in relation to labour-saving machinery.

This labour-saving machinery we are now extensively importing; and, as explained in our last issue, this export alone represents a very formidable section of American industrial returns. At first sight, the bringing into this country of an extensive stock of alien machinery seems to represent a lamentable deficiency on the part of our own British engineers. Part of the argument must be admitted, but on the other hand it will be seen that this importation, so far from being a drawback, is really an eloquent testimonial to the abilities of our home manufacturers.

It must be remembered that the producing industries of this country have been founded for many years upon accomplished manual labour, replenished by apprentices. In the past, British producing industry has been made and founded upon craftsmanship. In connection with the attendant apprenticeship system, it will be seen how far our manufacturers have cast aside the traditions associated with their industry through the installation of automatic machinery, whose factors are in antagonism to all trade conditions as they have heretofore subsisted.

There can be no doubt that Trade Unionism in this country has met the most dangerous competitor yet unencountered by this organization. The introduction of automatic machinery must be regarded as a death blow to the broad form of combination now existent and exemplified in such an organization as the Amalgamated Society of Engineers. Manual skill is at a discount, because the operations formerly performed by hand can be more perfectly executed at a much less cost by machinery.

The ultimate outcome of skilled labour organizations, in face of the superseding competition now facing them, is difficult to see. There can be no question of the fact that in the adoption of automatic machinery lies the solution of what is called the Labour Problem. We look upon this adoption, which is superseding on a scale only known to few, ordinary mechanical handwork, as a saving testimonial to the capacity and adaptivity of our British engineers. We, as a country, are intensely conservative; possessed by the belief that the methods we have adopted and continue to exercise are superior to those of any of our rivals. Yet we see that in spite of this prepossession, we do not nor shall omit any means of maintaining our supremacy, however inimical they may appear to us at first sight.

To summarise, no really active trade opposition is now being manifested against the employment of automatic machinery, both employers and workmen having apparently made up their minds to accept the inevitable. We lay great stress upon the importance of this new feature in British manufacturing economy, because we are assured that in due time it will become evident to the world at large.

One feature of the year to which we cannot refuse attention, although it does not come strictly within the scope of this Magazine, is represented in the term *Imperialism*. This we take to be another word for *Federation*, a Statesman's dream which has been unrealised for many years. Most important economic results will depend upon the accomplishment of this undertaking, which seems probable, and even certain, in the near future.

One feature in the unhappy disturbances which are disquieting the British realm is that relating to the transmission of news from distant spots to British centres. It is difficult to say why the Government, which has erected both postal and telegraphic transmissions into a "State Department," should not similarly take over the whole of the cables abroad and administer them in a similar fashion. The idea of associating the great arteries which inter-connect Greater Britain has, in one instance, been formally accepted, and which only a short time is required to see converted into a reality.

Taking the general circumstances of this country, as they now stand, a more hopeful prospect was never unfurled before any land beginning a new year. Our mills and manufactories, our merchants and traders are overwhelmed with business, and taking all in all, the year 1899 has been a term of prosperity which has not been equalled in the British Empire for many years past.

The Effect of Recent Inventions on Modern Warfare.

When it was first announced that an American engineer had succeeded in producing a light and simple gun that would load and fire itself over 600 times a minute by energy derived from the force of the burning powder, a gun which was so completely under control that a stream of bullets could be controlled with the same facility as a discharge of water from a hose-pipe, it was thought by a great many that it marked the beginning of a completely new epoch in warfare. Shortly after the invention of the automatic system of fire-arms smokeless powder made its appearance, and this was followed by the general introduction of magazine rifles. Military experts at that time became convinced that these new departures would add a great deal more to the defence than the attack, and there was much speculation as to how a country like England, with Maxim and magazine rifles, smokeless powder and excellent marksmen, would be invaded, and what military force could be the first to invade. It was pointed out that a squadron of cavalry in reconnoitring the enemy's position might come within close range of a concealed Maxim gun, when one gunner would be able to wipe out the whole squadron in a few seconds, whereas if artillery were the first to advance, the battery might find itself in close proximity to a concealed Maxim gun or a detachment of infantry, when the whole battery might be put out of action in a few seconds. At Thune, in Switzerland, Mr. Maxim was asked to fire at a dummy battery of artillery at a distance of 1,200 metres, and in one minute 75 per cent. of the horses and men were technically killed. When smokeless powder first made its appearance in France, experiments were made in regard to the possibility of discovering from what direction the force was being assailed. A detachment of troops was placed in various groups of trees and concealed in various ways. Upon firing it was found quite impossible to locate them, and, as the French officer said at the time, even if they did know from what particular place of concealment they were being assailed, it would be very difficult to take sight at a sound. When the American Rough Riders advanced on Santiago the first warning that they had of the existence of the Spanish army was the hissing of bullets and falling of the limbs of trees and the killing and wounding of the officers and men. Not a Spaniard was in sight, and the smokeless powder gave no indication from what quarter they were being assailed. The slight and distant rattle of musketry was barely audible, which gave absolutely no indication as to what direction the Rough Riders should direct their fire.

With the long-range rifles and the smokeless powder, such as is used by the Boers at the present time in Africa, the first indication that our troops have of the proximity of the enemy is the whistling of bullets and the dropping of men. In many cases the rifles may be fired at such an extremely long range that their sound is not audible. It requires very little to conceal a few men at a distance of 1,000 yards, whereas a few accurate marksmen with long-range magazine rifles are able to effect an immense amount of damage at this distance in a few minutes. The Boers are not only armed with the most powerful magazine rifles, but they also have a considerable number of Maxim guns, which were acquired several years ago.

Since the expiration of the Maxim patents, various modifications of this gun have been made in various countries, and we learn that a Paris company has recently furnished a considerable number of automatic guns to the Boers. These guns, although they do not fire with the same rapidity as the Maxim, which works with the recoil of the barrel, fire about 300 rounds per minute, which is quite fast enough to inflict a great deal of damage.

From recent events in the Transvaal, it would appear to us that there can be no question but that the advent of the automatic gun, magazine rifle, and smokeless powder has opened a completely new record in warfare, and that it calls for a complete change in our system of tactics. The Russians and Austrians are provided with a large number of Maxim guns, mounted on very light carriages provided with large bullet-proof shields. These guns are so light that they may be moved into any position without the use of horses at all. It is possible for several of these guns to advance over moderately level ground against infantry fire without much danger. Moreover, these guns may be grouped in such a manner as to completely shut out rifle fire, not only in front, but from each flank. It would appear to us that the time is arrived when it is imperative that our troops should be provided with some sort of shield, either fixed to the Maxim gun or detached and provided with wheels. Again, long and narrow shields, which could be rapidly inserted in the ground, might form a temporary protection to our troops until they had time to entrench themselves, when the shields might again be moved forward another step. Of course these shields would afford no protection against anything but rifle fire, but it is the rifle fire that one has most to dread from the Boers. If they use their artillery it can be located, and will at once become the target for our own artillery, and, as has already been abundantly shown, their artillery fire is, as a rule, very quickly silenced by our own guns. Some years ago, Mr. Maxim produced a little shield which created a great deal of excitement at the time. It was about a quarter of an inch thick and weighed 10 lb. to the square foot. This was the lightest and most effective shield that had been made up to that time, but we learn from a good authority that there is a firm in England at this time who can construct a shield which is equally effective and weighs only 9 lb. to the square foot even for very short ranges, whereas if the shields are placed at an angle at a range of 1,000 yds., 6 lb. per square foot is quite sufficient.

Quick-firing Guns.

At the present time much is heard about quick-firing artillery, and too frequently with reference to the armaments of our opponents in South Africa. The term in question is one of remarkable elasticity, and may appropriately be applied to almost any type of gun, from the ordinary breech-loader to the automatic machine gun.

During the past fifty years a considerable amount of ingenuity has been displayed by inventors and makers of ordnance with the object of enlarging the scope of individual pieces of artillery by increasing the speed of loading and kindred operations. In such a way it is possible for one improved gun to be invested with an efficiency equal to that of several ordinary guns, much in the same way that a high-speed engine is made to develop greater power than two or three machines of similar size but running at a lower rate of speed.

Unfortunately, where new things of any kind are involved, excessive caution and distrust have always characterised the attitude of our responsible public officials, and perverted virtues of this nature are not unknown in the present day. So far as breech-loading artillery is concerned, we find that the Armstrong gun was introduced more than forty years ago, and that ordnance of a similar type has for a long time been employed by several Continental nations. No doubt imperfections existed, but whilst foreigners went to work and produced improved forms of breech-mechanism, our own Government despairingly reverted to the previous system of muzzle-loading. Why a nation supposed to be pre-eminent in matters involving mechanical skill should have thus abandoned all effort in the proper direction, seems incomprehensible except on the hypothesis we have already suggested. As everyone knows, we spent large sums of money in the construction of costly muzzle-loading guns, which ultimately had to be thrown aside in favour of breech-loaders. To be strictly accurate, we will say they should have been thrown aside, for unhappily a large number still remain, both in the naval and military

branches of the service. When at last the superiority of breech-loading ordnance was driven home to the brains of our contemplative artillery experts, steps were taken to undo the work of previous years, but even this tardy reform exhibited no abnormal development.

The royal navy until recent years was crippled owing to the arrangement in virtue of which all guns were to be supplied by the military authorities. Naval guns, we are happy to say, are now furnished in accordance with requirements formulated by the Admiralty. Consequently we find that our modern war vessels have been armed in a manner which leaves very little to be desired, and which justifies confidence in their efficiency. In former times efforts were made to secure uniformity between the armaments of the sister services, and guns were then generally classified according to tonnage, almost implying that efficiency might be measured by the avoirdupois table. Under the new *régime* we hear less of weight and more of long range and quick-fire. Athough these are merely surface indications, they are sufficient to suggest the changes which have been effected with respect to naval ordnance.

Many years back, a well-known engineer suggested the desirability of making large guns by winding steel wire round a tube forming the barrel. This idea, needless to say, was neglected by our leisurely War Office, though it has been successfully adopted by private firms, and the Armstrong, the Crozier, and the Woodbridge wire-wound guns are now familiar and highly-valued weapons. Everyone who has followed recent accounts of the campaign in South Africa is fully aware of the invaluable services rendered by naval 4·7-inch wire-wound guns, and we may all hope that some day the War Office will provide equally efficient artillery for the army. As instancing the laudable enterprise displayed by our naval authorities, we cannot do better than to refer to the guns about to be mounted in the new battleships *Glory* and *Irresistible*. The weapons in question are 12-inch Armstrong wire-wound guns, of which a description was given in our last issue, the Vickers-Maxim mounting is fitted with a chain-rammer, specially designed to facilitate rapid loading, and there will also be provided the usual arrangements for the prompt supply of ammunition. A noteworthy feature is that the mountings are constructed in such a way as to permit of the guns being worked entirely by hand if this should become necessary. It is a gratifying testimony to British enterprise that this important condition has been fulfilled, especially when we remember that the 10-inch gun proposed for the new cruisers of the American navy, will only be under the control of appliances worked by hydraulic or other power.

Turning from the consideration of naval ordnance, we find less cause for congratulation. The equipment of the army has exhibited little improvement; and the War Office have stood still until foreign nations, possessing their own gun factories, and others who buy from British and foreign manufacturers, are clearly our superiors in respect of artillery. Latterly, we have heard the epithet "absent-minded" applied in connection with military men; this mental qualification is marvellously exemplified in Pall Mall, where its origin is apparently lost in antiquity. Looking back into the past history of quick-firing guns, we find such appliances have seldom, if ever, been adopted by our authorities until long after foreign nations had proved their absolute necessity. The Gatling gun, one of the pioneers of machine guns, was first used in the American civil war with marked success. Furnished with from five to ten barrels, fed from a hopper by a feed-case, this gun is capable of firing 1,000 shots per minute. It has been largely taken advantage of by many countries, amongst whom we were by no means the first in point of date. The Mitrailleuse, employed with considerable effect in the Franco-Prussian war, received the favourable attention of several Continental Governments, but not of our own. Amongst other well-known machine guns may be mentioned the Gardner, the Hotchkiss, the Nordenfeldt, the Maxim, and the Maxim-Nordenfeldt. The Hotchkiss gun is really a small revolving cannon of long

range, firing small shell with great rapidity; it has five barrels arranged round a central axis, the breech is fixed and contains the loading, firing, and extracting apparatus, and the various operations are performed during periods when rotation is interrupted. About 30 to 80 rounds may be fired per minute, resulting in the production of from 750 to 2,000 fragments, having force sufficient to destroy life. Formidable as such an engine of war may be, it is far outclassed by the more recent type of Maxim field-gun, illustrated in our December number, and used against us at the present moment in the Transvaal. This deadly weapon, although made in Germany, was supplied several years ago to the rebellious republic with the full knowledge of our own authorities, and it is also used in the navies of other countries. Light machine guns, and artillery in fortified places or on war ships, are, of course, always furnished with mechanical devices for facilitating rapidity of fire; so far as the guns constituting our field artillery are concerned, we fear the only justification existing for their classification as "quick-firing" is to be found in the provision of breech-loading mechanism. Unfortunately this modest qualification is not universal. Not only is the Natal Field Artillery Corps furnished with obsolete muzzle-loaders, but some of the howitzers and other guns provided for our regular troops are of the same archaic type. We may well enquire whether field guns can or cannot be furnished with auxiliary appliances, tending still further to increase the rapidity of their fire. A ready answer to this question is at hand. An apparatus for the very purpose has been patented by Sir George Clarke, K.C.M.G., Lt.-Col. of Royal Engineers. Briefly described, the appliance is one capable of attachment to field and other guns, and which provides for raising the projectile into exact alignment with the bore of the gun at any angle, so that loading may be effected in any position of the gun. The lifting apparatus consists of an arm pivotted near the axis of the trunnions, carrying a rammer and connected with an auxiliary arm carrying a loading tray arranged to be operated by mechanical means. The loading tray picks up ammunition from a platform, which may be supplied by a travelling carrier or otherwise, as most convenient, and, further, there are modifications providing for loading in the event of failure of supply to the platform. This is an ingenious invention, the advantage of which is transparently evident to the ordinary brain, though hidden from the more complicated intelligence upon which the national safety depends. Sir George Clarke's attachment was actually fitted to one field battery in February last, but we believe was not sent on service.

For months past Lord Charles Beresford and another member have constantly interrogated the War Office on the subject of quick-firing field guns, knowing that equipment of this kind was used in Germany, in France, and in the Transvaal. The only reply obtainable was that the War Office were waiting for the evolution of a perfect quick-firer before putting the country to expense. They are still waiting. Our sorely tried officers and men in South Africa are also waiting. In the meantime our military authorities are just beginning to learn from the Transvaal war, what every layman learnt from the German manœuvres, that artillery is the essential factor in modern warfare. If quick-firing field guns, such as are readily obtainable and firing common or lyddite shell at 6,000 yards, had been furnished, hundreds of lives would have been spared in recent engagements, and our forces would have enjoyed freedom of movement within a fire zone which the enemy would never have dared to penetrate. The armaments of our adversaries have for some years been known to include quick-firing long-range guns of the most perfect types, and at no distant date enquiry will have to be made as to why the War Office permitted our troops to be confronted with artillery to which they could make no efficient reply.

"ELECTRIC FIRES" will form the subject of an interesting series of articles commencing in an early issue.

Readers may also shortly anticipate a unique contribution dealing with "INCANDESCENT LAMPS."

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—Rt. Hon. Lord Charles Beresford, C.B.

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The Sewage Problem . . .

In this issue we commence a series of articles by Dr. Samuel Rideal upon a subject that has long engrossed a large share of public attention. The Disposal of Town Sewage is a question that has long remained an open one, and one on which a number of conflicting theories exist. The problem involved in connection with sewage has been dealt with in many different fashions, and include the use of perforated screens, cascades, weirs, heated air charged with vapour or under pressure, filtration and precipitation, electrolysis; and now, we are told the bacterial treatment of sewage is a final solution of this most perplexing problem.

That it was possible to effect the purification of organic matter by means of living organisms was known early in the present century, but very little exact knowledge on the subject was arrived at until Pasteur proved that fermentation and putrefaction did not take place without the aid of living organisms. The researches of English and Continental scientists have thrown a definite light on the question, so much so that the bacterial treatment of sewage has become a commercial possibility.

The bacterial purification of sewage consists in bringing the sewage into a septic or putrid condition, either by keeping it in a covered tank or by obtaining similar conditions by allowing it to flow through anærobic beds or to stagnate in contact beds and filtering through coke or coke breeze filters. The best example of this method of treatment in this country is to be found at Exeter, where a plant adapted to a population of 1,500 was installed several years ago. Another installation on a similar principle is at Sutton, Surrey, where a "bacteria" tank is used for the liquefaction of the sewage. It is claimed by the advocates of septic methods of sewage purification, that satisfactory results are secured. There appears, however, to be some conflicting evidence on this point, and it is stated that at some of the experimental works the filters have failed to perform the work of purification, slowly becoming choked up and useless, thus indicating that the bacteria which should have liquefied the sludge in the first part of the process have not done their work properly.

Another system which has had a large measure of success is represented in the ærobic bacterial system with polarite oxidising beds, dispensing with septic treatment or coke beds. It is stated that the effluent coming from these beds is found to contain as much dissolved oxygen as is present in many good drinking waters.

It has been demonstrated that under skilful management the ordinary work of a polarite filter is at the rate of 1,000 gallons per square yard per 24 hours, which is equivalent to 4,840,000 gallons per acre, which compares very favourably with the work of filtration capable of being executed by an ordinary coke filter.

In its purifying properties, it is claimed

for polarite that it gives a far higher degree of purity than can be obtained by coke or other filtering material, as it acts as an oxidizer of organic matter in solution, whilst coke only acts as a strainer. Coke filters, however, act very satisfactorily, although there is a tendency when worked for a length of time on a practical scale for them to choke, as was found in the case of the well-known experiments with a 1-acre coke filter at Barking, where continuous running resulted in clogging and a foul effluent.

The Barking filter is an example of a process which includes a preliminary precipitation and subsequent transport of the sludge, and this combination of chemical and mechanical treatment is in vogue in a large number of places.

There are many other systems of sewage treatment, but they may all, roughly speaking, be divided into antiseptic and septic systems. Regarding the relative merits of the two, it is almost impossible to come to a broad judgment, so much is the consideration of the subject complicated by local conditions. It must, however, be noted that Omelianski has shown the existence of a group of bacteria having three different characteristics and producing three different chemical results in the decomposition of organic matter, but he has also shown, inferentially at least, that the conditions necessary to the action of one class are the opposite to those of another class, and that, therefore, they may at times set up conditions mutually antagonistic to one another. Hence, so far from the use of chemicals being erroneous in sewage disposal, it might be logical to conclude that in the case of towns at least the use of chemicals is essential to re-adjust the bacterial proportions necessary to effect perfect decomposition.

Many endeavours have been made to sterilise sewage by chemicals with a resultant double product consisting of an effluent which soon became putrid owing to the occurrence of more bacteria and the sludge that needed further expensive treatment.

An antiseptic system that has been successful, however, occurs in the installation at Henley-on-Thames—an instance which conclusively demonstrates the necessity for local circumstances to be taken into consideration in the final disposal of sludge and effluent. Before the antiseptic system was applied there the outfall works, from a system of precipitating tanks and filters, were a source of some nuisance. The effluent has now, however, under the antiseptic system, showed no tendency to sewage sickness, and the sludge has been utilised to fertilise the sandy gravel.

After all, the point in the general treatment of sewage that is most likely to impress the economist is, that all the efforts are made to destroy sewage, and not to utilise it. A writer in this magazine pointed out last month that the Chinese, for instance, would regard the waste of enormous bodies of nitrogenous matter as practised here with unbounded amazement. The difficulties, it must be granted, of employing sewage in this country in anything like the manner in which it is utilised in China are overwhelming. But when vast quantities of rich fertilising matter remain wholly unutilised, we cannot believe that science has said her last word on the question.

Aerial Navigation . . .

THE great difficulty of assailing the Boers in their rocky strongholds has called attention again to the great desirability of some means of aërial navigation which should be sufficiently effective to enable the attacking party to reconnoitre the enemy's position. Ten years ago the Americans, the Russians, the French, the Germans, and ourselves were experimenting with war balloons. No great success, however, attended these expensive experiments. Major Renard, a French engineer, was the only one who succeeded in navigating a balloon at all. On one occasion he succeeded in making the balloon travel about for a few miles and then return to the starting point, but this was in a dead calm. After that no success was achieved. Some six years ago Mr. Hiram Maxim commenced a series of experiments with a view of ascertaining how much

power would be required to perform artificial flight without the use of a balloon. His experiments demonstrated that both lifting and propelling power could be obtained, but that it required a very great deal of experimenting in order to be able to balance the machine in the air. Mr. Maxim's machine was on the aërial plane system, and it was shown that with a pair of large screws and an expenditure of about 360 H.-P. these screws would give tractional force of 2,200 lbs., and would give to the machine a speed of 42 miles an hour, at which speed the lifting effects of the aërial plane was 10,000 lbs. Prof. Langley made a similar machine one-twelfth part the size of the Maxim machine, or an inch to the foot. Prof. Langley, after making experiments over water, succeeded in balancing his machine in the air, and it made several successful flights for a distance of half-a-mile ; but this, of course, was only a model. Mr. Horatio Phillips, who is one of the cleverest engineers we have, also made a machine which clearly demonstrated that propelling and lifting effect could be obtained. We now learn that these demonstrations have been sufficient to discourage any further experimenting with balloons, except in Germany. The French Government and the American are both experimenting at the present moment with flying machines, using the aërial plane, and with a fair chance of success.

It is said that whenever a great want manifests itself some one is sure to come forward to supply that want. At the present moment we are greatly in want of a machine for reconnoitring the enemy's position, and we have all the skill and money in England which is necessary to carry these experiments a little further to achieve success. The American Government has appropriated £5,000 for experimental purposes. The French make very much larger appropriations and employ the cleverest engineers. Why could not England do likewise ?

Joint-Stock Law . . .

THE proceedings that took place recently in the Law Courts concerning the promotion of a certain trading company under limited liability threw light only on one side of a state of affairs in connection with the Limited Liability Acts that is rapidly becoming intolerable. The last report issued by the Bankruptcy Department dealt vigorously with the abuse to which the Companies Acts are now subjected by unscrupulous traders. Certainly it is time, and more than time, some measures should be taken, not so vigorous as to be harassing or to frustrate the legitimate working of the Limited Liability Acts to the fullest extent, but sufficiently efficacious to suppress a form of fraud that, it appears, can now be committed with impunity.

The examination of the Lord Mayor of London was relevant chiefly to a question of directors' profits. However mischievous it may be for a director to possess a secret interest in the sale of property to a company, it cannot be said the evils attending such a practice are in any way comparable in extent to those associated with the issue of debentures. The issue of debentures, especially in connection with small industrial companies, has certainly reached the position of an anomaly. A trader, trading in his own name, cannot raise money on his property without incurring the publicity of a bill of sale. But let this trader transform himself into a limited company and he may mortgage the whole of his possessions without one of his creditors being the wiser.

It is now a common-place in connection with the winding-up of a limited company to be informed that the whole of the available assets have been taken by the debenture-holders, and that the ordinary creditors will get nothing. Generally speaking, the class of companies to which we refer have been created for the purpose, not of raising capital under limited liability, but for borrowing money without injury to the credit of the business.

We venture to offer the opinion that all issues of debentures should be registrable under the Bills of Sale Acts, and submitted to a similar publicity. Such a regulation would at one stroke accomplish a great part of what is wanted by the leaders in "company law reform," and besides

exposing the true position of the business with which such debentures might be associated, would only be just to manufacturers and traders who preserve their own trading individuality.

Progress in Egypt . . .

SINCE the advent of British control, Egypt has provided a continuous object lesson of what may be accomplished by persevering energy in the face of natural and artificial difficulties. The country was bankrupt, its people oppressed, and its public works in a deplorable condition. At the present moment Egypt is solvent, its people are prosperous and free, and wonderful strides have been made with regard to the perfection of all public works, and notably those controlling the River Nile. More than this, the Soudan has been re-conquered, and its restoration to a state of prosperity is only a matter of time. Fortunately the men who are entrusted with the direction of affairs are men of action, and when they have decided upon the execution of any given work no unnecessary time is lost. Of course there have been hindrances, but these are solely attributable to the unfortunate arrangement by virtue of which other nations are permitted to debar Egypt to spend her own money for the provision of absolutely imperative national requirements. Immense progress has already been made with the vast engineering works destined to regulate the waters of the Nile; and now promptly following the last crushing blow at the power of Mahdism, further operations are to be commenced in the upper reaches of the river. Between Khartoum and the mountainous region in the neighbourhood of Lake Albert, there are low-lying swampy districts where the river gathers immense quantities of vegetable *débris*, technically described as "sudd," and which gradually accumulating forms impassable barriers to navigation, and hinders the proper flow of the water to Khartoum. Mr. Willcocks, well known in connection with hydraulic engineering in Egypt, has recently reported that the Bahr-el-Jebel, which formerly carried nearly all the water coming down from the equatorial lakes, is now blocked for a distance of 200 miles, and that the main river above the Sobat is in some danger of being obliterated by sudd. These depressing facts are fortunately somewhat discounted by the comparative freedom from sudd of another watercourse known as the Bahr-el-Zeraf. Mr. Willcocks therefore recommends that the head waters of the latter should be cleared from sudd, so as to open a wide channel into the Victoria Nile, and at the same time he proposes the Bahr-el-Jebel should be closed at its head by a dam. The work is now to be commenced, and it is anticipated that about a year will be required for its completion. Further advantage will, however, be secured if dykes are constructed in various places where the river banks are low, so as to prevent overflow in times of flood. Mr. Willcocks estimates the cost of these additional works at £600,000, and considers the expenditure might be spread over ten years. The ultimate result would be to transform the Nile into a well defined and swiftly flowing stream, and to add still further to the prosperity of Egypt. Within the next fifty years there are going to be immense developments in Northern Africa. Foreign nations are already participating in the advantages which have followed our work of reformation, though some of them bite the hand which offers them food. We shall, of course, continue to afford equal facilities for the traders of all nations, but it will be our own fault if we do not secure our own pre-eminence.

Development of the Rotary Engine . . .

THE rotary engine is an old friend, but an unsuccessful one. It bears a relation to the reciprocating steam engine, similar to that existing between the unappreciated genius and the prosperous business man. Absolutely sound as to theory, it has hitherto been a failure, simply because the mechanical difficulties presented have not been entirely overcome. Surely in these days of enlightenment and progress it should be possible to find some

one capable of solving a purely structural problem, however great may be its actual and traditional perversity. The substitution of rotary for reciprocating steam motors means immense saving in the cost of construction, in space occupied, and in loss of power by friction. Cranks, piston-rods, cross-heads, guides, connecting-rods, counterbalance-weights and massive fly-wheels, with their disadvantages, would all be abolished. Steam engines would be largely deprived of their powers of causing injury and damage, both on land and at sea, whilst vibration and noise would be reduced to an absolute minimum.

One advantageous feature in connection with the rotary engine is the fact that pressure on the piston is always tangentially applied, and so dead centres are non-existent; consequently the turning moment is at a maximum throughout the whole of each revolution. A knowledge of these facts has induced innumerable attempts to carry them into actual practice, but hitherto with little success. Many extremely ingenious designs have been produced by such engineers as Fletcher, Cochrane, Napier, Myers, Massey and others, but with the exception of the Parsons Turbine, no rotary steam engines have been established in successful competition with those of the reciprocating type. Nevertheless, the thought and skill displayed has not been lost, for they have tended to suggest and improve various types of pumps, air-blowers and ventilators which are extensively used and appreciated. Speaking of the rotary engine in the simplest terms, we find it to consist of a cylinder, having an internal disc keyed to the main shaft so that an annular or other space is left, in which steam exerts pressure on the piston. Taking the case of an engine with an annular steam space, the piston would be made to fill it completely, whilst steam would be admitted and removed through ports, by the aid of some suitable form of valve gear. So far, everything seems simple, but as the steam must be free to move in one direction only, it is clear that a barrier has to be interposed at some point within the annular space behind the piston. This barrier, termed the abutment, should be fitted between the inlet and outlet ports in such a manner that it may be quickly removed to permit the piston to pass at the completion of each revolution, and as quickly replaced as soon as the next cycle begins. Hitherto the chief difficulties have been (*a*) to actuate any of the many types of abutment with sufficient rapidity without causing injury to the mechanism, and (*b*) to reduce clearance between abutment and piston to such an amount that the latter shall be subject to pressure practically throughout the whole stroke. Contrivances for the admission and control of steam have also given more or less trouble, especially as concerns the adjustment of cut-off, so as to derive the best possible effect from the expansive use of steam. In an engine lately designed by Mr. Colwell, of Chicago, the points in question are dealt with in a practical manner, and although his engine is probably not sufficiently perfect, it constitutes a marked advance in the right direction. The Colwell engine has two cylinders, each with an annular steam space, the pistons are segments of a circle, with faces radial to the centre of the main shaft, and they are provided with split packing rings. Rapidity in the movement of the abutment is aided by the adoption of horizontal swinging mechanism, comprising a vertical shaft, on which the abutment-disc is pivoted; the shaft is attached by a rocker-arm and connecting-rod to an oscillating disc, worked indirectly from the valve gear link-motion. As soon as the piston approaches within a given distance of the abutment, the latter is swiftly swung aside, and when the piston has passed, the rocker arm is "tripped," and the abutment swings back to its original position, the requisite impulse being given by a dash-pot connected with the oscillating disc. Corliss valves and gear are adapted for the control of steam, and so far their action appears to have been of a satisfactory nature. We should now like to hear that some enterprising British inventor has made up his mind to revive experimental enquiry with regard to this form of engine, for which there is an immense future, providing only that practice can be brought within measurable distance of theory.

Notes.

WE present with this issue a complete index and title-page to the first volume of FEILDEN'S MAGAZINE, which for convenience in binding, terminated with the December number. Our readers may probably be aware of the phenomenal success that attended the publication of this Magazine, and which might be held as a justification in remaining contented with the standard reached in the first volume. Two new features will, however, be found in the present number, namely, (1) a section in which will appear ideas and improvements in Workshop Practice suggested by heads of departments, foremen, and skilled mechanics; and (2) a modification of the plan on which the section "The World's Industrial Engineering Press" has hitherto been conducted. We venture to believe that these new features will be very generally appreciated, and be calculated to amplify the generous support already accorded to the Magazine, as they have been for some time past in contemplation, and are largely due to the suggestions received from many of our engineering friends.

WE have had brought before our notice what appears a novel and interesting method of generating acetylene gas, by which, as claimed, not only is the gas generated in such a way as to dispense with almost all the valves, etc., now necessary in generators, but the bye-product, being the result of a chemical re-action, is one of industrial value, and as such can be readily utilised. No water is used, and the process is inexpensive, and appears to work very satisfactorily.

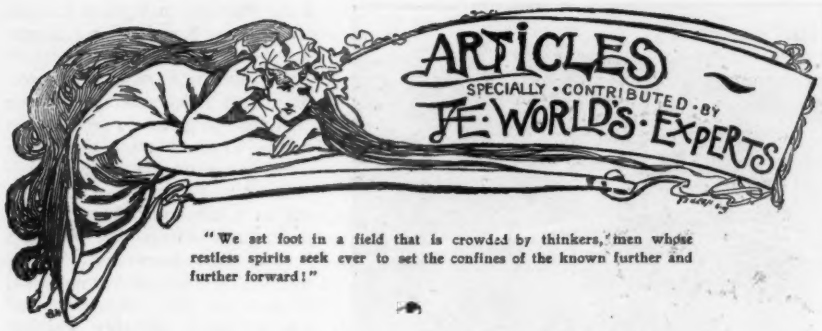
Is it possible to manufacture carbide of calcium by steam power at a cost that will enable the product to compete with natural-power carbide? Theoretically speaking it is, especially if Mr. Swinburne's method of computing water-power be accepted. It seems, however, to be the fact that steam will not be used much for calcic carbide manufacture. One carbide steam installation, if not two, in this country, has proved a failure. It is probable that patents in the production of carbide will have little effect in producing a monopoly compared with the monopoly of water-power. It appears to be the fact, however, that steam-made carbide can be produced at a net cost of some £9 a ton.

AT a time when the obtaining of a good motor-car with anything like prompt delivery is a difficult matter, it appears strange that an "Association" of motor-car builders should be found necessary. The organisation, if it can be called an organisation, is clearly due to the initiative of Mr. H. J. Lawson, whose pertinacious exertions in this and other directions to be regarded as the "father" of the motor-car industry have met with hardly the success their author has appeared to anticipate. When all the good makers are demanding and receiving their own prices, where is the use of an "Association"?

SINCE the publication of our last issue we have received from Mr. Hudson Maxim, of Brooklyn, New York, an extensive budget of letters and periodicals, the latter containing signed contributions by himself on various subjects. We have not been, at the time at our disposal, able to see that these have any definite bearing on the merits of the question involved. This, so far as we can make out, is simply one of precedence; and we think it would have been more to the point if Mr. Hudson Maxim could have referred us to any patents, literary productions, or other data referring to his claims published at or about the date when these claims arose. The articles submitted to us are all of quite recent date; and although we have perused them, we cannot say they have exercised any appreciable effect on our previous judgment. We are, however, looking more closely into the matter, and will probably clear the whole subject up in an early issue.

SUP

SAMUEL RIDEAL, D.Sc. LOND., F.I.C.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

The Bacterial Treatment of Sewage.

By SAMUEL RIDEAL, D.Sc. Lond., F.I.C.

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DR. RIDEAL is a distinguished graduate of the University of London and of University College, London, and was elected a Fellow of the College in 1887. Since that date he was for some years Lecturer on Chemistry at St. George's Hospital, London, and has for the past ten years devoted his attention to Sanitary Science. His book on "Disinfection and Disinfectants" is looked upon as a standard work, and that on "Water, and its Purification" has earned a well-deserved reputation as a book of reference on problems of water supply. He has recently been a strong advocate of the modern methods of bacterial purification of sewage, and his Cantor Lectures before the Society of Arts early last year are the most exhaustive account of this important subject. In a paper before the Sanitary Institute, in 1896, he was the first to draw public attention to the now well-known Exeter System; and, by his careful and well-devised experiments, established the conditions for the successful working of the anaerobic process. He is a Fellow of the Sanitary Institute, a Member of the Council of the Institute of Chemistry, and a Vice-President of the Society of Public Analysts.

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ALTHOUGH, as Sir Wm. Preece remarked in his address to the Sanitary Congress at Southampton, "the new biological treatment is a return to nature," it has taken a very long time to unravel the sequence of changes which bring about the purification of sewage, and even at the present time, in some of the newer bacterial schemes, natural conditions are far from being realised. In the evolution of a new idea it is obvious that definite conclusions will only be arrived at after many abortive attempts at success, and that this is true in the special case before us has been amply demonstrated by the work of the last few years. The destruction of organic matter by burning was so obvious that when in recent years chemists pointed out that oxidation could take place at ordinary temperatures in water, by means of bacteria, it was looked upon as the final solution of the problem, and nearly every departure has been in the direction of endeavouring to ensure the admixture of atmospheric oxygen with the organic matter under the most favourable conditions. That considerable improvement was likely to be effected in this way was clear, but whether the organic matter was capable of being directly oxidised without being prepared for the work was little considered. It was known that when the suspended

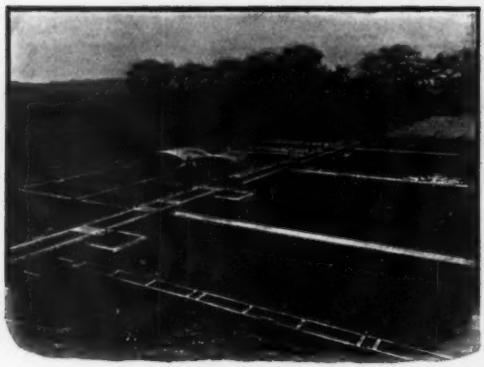


FIG. 1.—CONTACT, OR "DIBDIN," FILTERS ON DUAL SYSTEM AT SUTTON.

solids from sewage were removed by precipitation or clarification, the clear effluent could be rendered innocuous by passage over land, by admixture with river water or by passage through artificial filter beds. An illustration may, perhaps, render this clearer. Coal when directly burnt, even under the most favourable conditions, always yields, besides the inorganic ash, more or less unburnt carbon in the form of coke and volatile gaseous products accompanied with sooty particles. It has therefore been found for the perfect combustion of coal to be more economical to subject the coal to a preliminary treatment whereby one obtains the coke and gas, each of which can be utilised for the production of heat separately; both, when burnt under suitable conditions, yielding oxidised substances, free from products of incomplete combustion, thereby ensuring the utilisation of the full heat-energy of the original coal. Further, in the production of water-gas from coke, the decomposition into hydrogen and the partially-oxidised carbon monoxide gives to the engineer a gaseous fuel which has advantages over the coke itself. This preparation of the fuel for its final oxidation, although not essential for some sort of result, is necessary for the *best* results, just as in the bacterial purification of sewage by atmospheric oxygen, a preliminary preparation is also essential if the highest purification is to be effected. "Nitrification" is not simply the oxidation of the nitrogen occurring in sewage to nitric acid, since the conversion of the complex organic nitrogen in sewage to nitric acid takes place through a series of distinct, well-defined steps, and the best oxidation results are obtained when the organic nitrogen is first converted into ammonia. Some recent experiments of Omelianski conclusively prove this point, and support me in the view which I have held now for many years, viz., that an anaerobic preliminary is an essential for success. Although this investigator was not studying the sewage problem, his experiments with pure cultures of the nitrifying bacteria have shown that they have absolutely no action upon the nitrogen of organic compounds, no matter how this nitrogen is combined, and that therefore in order that the organic compounds of nitrogen may be oxidised, it is essential that they should be first converted into ammonia by organisms distinct from those which nitrify. Now, ammonia contains no oxygen, and therefore it follows that oxygen is not necessary in the first stage of the process. At the risk of being too technical, I wish to draw attention to a few details of Omelianski's experiments. Three organisms, viz., Bacillus racemosus, nitrosomonas, and nitrobacter, when added to bouillon containing organic nitrogen, converted the latter into nitric acid; ammonia and nitrous acid being intermediate stages. The first of these organisms produces the ammonia from the organic nitrogen, the second converts the ammonia into nitrite, and the third the nitrite into nitrate. The first change requires no oxygen, the second change requires some oxygen, and the final change a still greater quantity. With a culture of the first two organisms, nitrite and no nitrate was produced. With a mixture of Bacillus racemosus and nitrobacter, ammonia was the only product, as the absence of the nitrous-forming organisms prevented the conversion of the ammonia

into food for the nitrifying organism. A mixture of the two last organisms failed to determine the decomposition of the original culture medium even after ten months. With these experiments before us, it is easy to understand the success and the want of success of the many experiments on sewage purification of the last few years.

From being relegated to comparative obscurity as an unsavoury as well as difficult subject, the problem of sewage disposal has within recent years acquired a prominence that is not without its dangers. One of the greatest is that we should forget the principles that have been slowly worked out, in attention to details of construction, or to processes bearing particular names. Any description, therefore, of existing methods of treatment must, to be useful, be accompanied by explanations of the chemical changes involved.

The main difficulties in dealing with modern sewage consist in its varying character, and its large volume, owing to the development of communities and of manufactures, so that the early methods of burying in earth, or discharging straight into rivers, have become insufficient and unsafe. The constituents may be classified as:

(1.) Solid and liquid excreta of men and animals.
(2.) Household waste.
(3.) Rain and storm water, and the water that is used to wash away the two preceding.
(4.) Road grit, sand, and mud.
(5.) Refuse and wash-water of trade and manufactures.

The rainfall makes a great, but irregular, difference in the quantity of sewage. Baldwin Latham states that 0·1 to 0·2 in. per hour increases the outflow of a sewer to five or more times its volume; but Santo Crimp, in gaugings at Wimbledon, found that there was no exact relation between recorded rainfall and increment of flow at the outlet, the size, length, and inclination of the sewers affecting the result.

FIG. 2.—ROTARY SCREEN FOR CRUDE SEWAGE AT SOUTHALL SEWAGE WORKS, ISLEWORTH.

Fresh sewage varies greatly in character, and may be sometimes very offensive. The matters in it are subject to the softening and breaking down influence of the water present, with at first a certain amount of oxidation, due to the oxygen always dissolved by natural waters from contact with the air. But this is small in amount, as when fully saturated at low temperatures there are only about 7 cubic centimetres of oxygen in one litre of water, equal to 700 parts in 100,000 by volume, while in hot weather the solubility is much less.

Since the gas is $\frac{1}{700}$ of the weight of water, the total dissolved oxygen amounts to but 1 gramme in 100,000, or $\frac{7}{10}$ of a grain per gallon, a quantity quite inadequate to deal with the organic substances, which ordinarily amount to from 20 to 40 grains. Re-absorption from the air is comparatively slow, even if aided by cascades, weirs, or even by forced aëration. At the time when oxidizing or burning up of the organic matters was held to be the sole means of purification, much money was spent abortively on schemes of aëration, and subsequently on chemical methods of supplying oxygen at immense cost from oxidizing solutions like the manganates, chlorine, and ozone. The key to the failures was found in the discovery that if sewage were sterilized, oxygen had no effect on it till the liquid had been re-inoculated with the proper organisms; therefore it was to the cultivation and encouragement of these latter that attention should be given. Powerful chemical agents only destroyed or enfeebled them; precipitants produced a more or less clear liquid, which rapidly turned foul, and a voluminous sludge which was not only difficult to dispose of, but removed from the liquid the useful purifying organisms upon which its final purity depends. A similar result accrued from a simple straining or mechanical filtration.

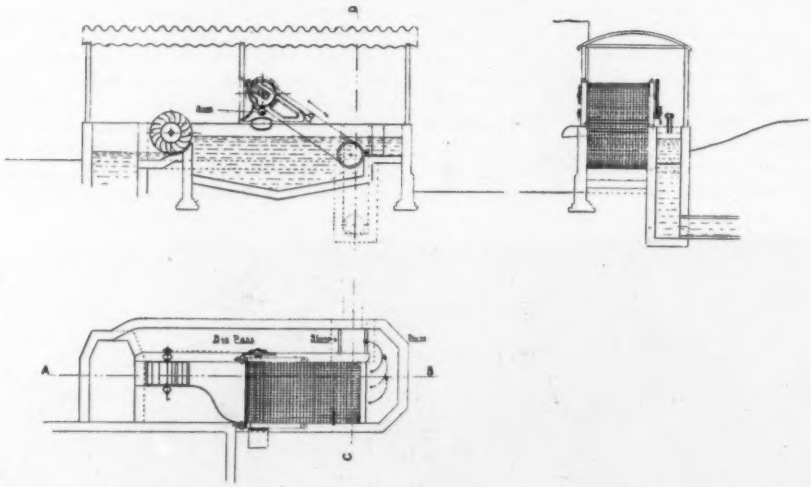


FIG. 3.—PLAN OF ROTATING SCREEN FOR RAW SEWAGE (J. SMITH AND CO., CARSHALTON).

Next it was established that the living agents most active and in greatest number were the bacteria. The necessary presence of minute life in fermentation and putrefaction had been long recognized, from the time when yeast, first seen as spheroidal cells by Leuwenhoek as early as 1680, had been proved about 1820 by Cagniard de la Tour to be a living plant; while Schwamm, in 1837, had shown that air which had been sterilized ("calcined") would not cause putrefaction. Pasteur

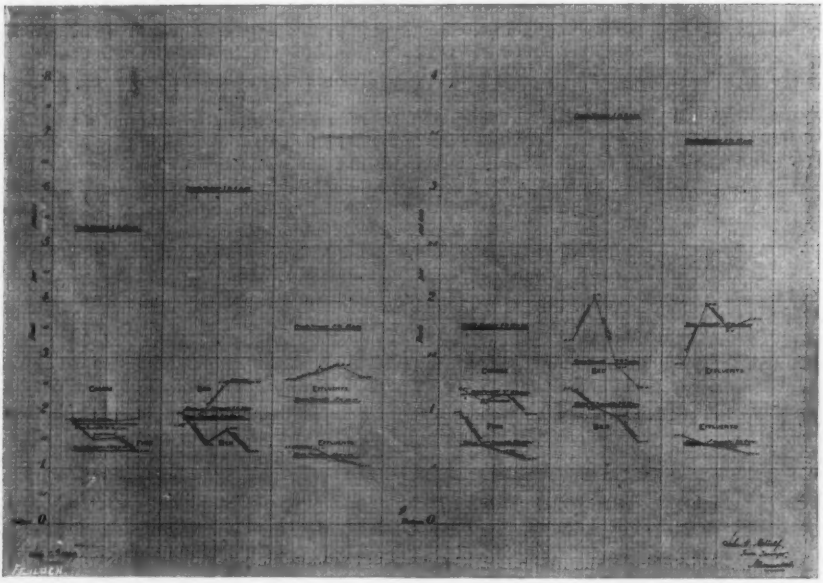
divided the organisms into aerobic and anaerobic, according as they were capable of living in presence or absence of air. Koch and others systematized the characters of bacteria; Warington, P. Frankland, Schloesing, and Winogradsky worked out their action in nitrification; and Muntz, Müller, Marie Davy and others their *rôle* in other changes of sewage.

The knowledge thus gained laid the foundation of the modern bacterial

on the results of his experiments on aëration of river waters, proving that "the consumption of oxygen from the dissolved air of a natural water is due to the presence of growing organisms, and in the complete absence of such organisms little or no oxygen would be thus consumed;" and again in May, 1886, proposing "to cultivate the low organisms on a larger scale" for purposes of purification.

NEWMARKET ADJOURNED INQUIRY (1899).

Results of Analyses of a series of samples of sewage, coarse and fine bed effluents from the bacteria beds Sutton, Surrey, personally collected on the 20th of June, 1899, and analysed by Dr. Rideal.



Albuminoid Ammonia. **Oxygen consumed in 4 hours.**

FIG. 4.—DIAGRAM SHOWING PURIFICATION EFFECTED BY "DIBDIN" BEDS AT SUTTON, AFTER SCREENING THE RAW SEWAGE. THE RAW SEWAGE AND COARSE FILTRATES WERE FILTERED BEFORE ANALYSIS.

methods of sewage purification. It is pleasant to be able to say that the practical application is mainly to the credit of English engineers, biologists and chemists.

The idea was first distinctly enunciated in this country by Dupré in 1884 in a report to the Local Government Board

Dibdin also at the Institute of Civil Engineers in January, 1887, pointed out that antiseptic processes, like the treatment with chemicals then in vogue, were "the very reverse of the object to be aimed at," which was "the ultimate destruction, or resolution into other combinations, of the undesirable matters" . .

"by organised bodies such as bacteria, &c., which give rise to the phenomena known as putrefaction." Later in 1887 the well-known Massachusetts experiments commenced.

The trials of different filters instituted by the London County Council in 1891 have often been described. The report of Mr. Dibdin contained several points that bear significantly on our subject.

Ideas on sewage filtration, whether natural through land, or artificial by means of beds of various materials, had undergone a progressive change. The mere physical function of clarification had been replaced by the chemical theory of the late Sir E. Frankland, and this in its turn by the recognition that the agents of change were almost entirely bacterial. Dibdin and Thudichum's figures showed that although sand and gravel effected a greater clarification, the removal of dissolved organic matter was considerably less than with coarser materials, of which coke-breeze and burnt ballast were found to be most efficient. Periodic rest for aëration was found to be necessary. While in the older process the *removal* of bacteria was a principal object, as now in the case of water filters, it was here demonstrated that the organisms in the filtrate were usually in larger numbers than in the sewage, and that their presence was evidence of the activity of the breaking up of organic bodies passing through. The outcome of the experiments was the well-known one-acre coke-breeze filter at Barking. It consisted of 3 ft. of coke and 3 in. of gravel, and was filled and emptied twice daily, and fed at first with small quantities of liquid, with a view to obtaining an active bacterial bed.

At the end of a month, when the daily tests showed that the highest efficiency (83 per cent. purification) had been reached, the feed of liquid was gradually increased to one million gallons daily, while the resting intervals were shortened. The system inaugurated was that still in practice at Barking, Exeter and Sutton, namely, alternate filling, resting full, and emptying, with a periodic entire rest empty for complete aëration.

In 1894 part of the town sewage of Sutton, Surrey, was similarly treated in ballast beds formed by digging out the clay to the depth of about 3 ft., filling the space with the same clay after being burnt and screened, and running in small quantities of liquid till the beds become bacterially active.

Hitherto the very name of bacteria had been held to be almost synonymous with disease; and it was only slowly that a principle was acknowledged underlying the whole system of bacterial treatment, namely, that while a few species are potent in destroying human life, the majority are not only innocuous but actually beneficial to it by effecting changes in effete matter, and could be trusted to carry out the purification without expensive adventitious assistance; moreover, that the latter class could actually be relied on to starve out and kill the harmful disease-producing forms. The latter point has now been exhaustively proved. At Sutton, in 1896, chemical precipitation was definitely abandoned, but an important feature of mechanical aid was still retained, since the raw sewage was "screened from grosser solids" by a revolving wire drum. The amount of solid matter thus avoided in the Sutton treatment is not stated, but may be estimated in ordinary cases at "30 barrow-loads per day per million gallons." Taking a barrow-load as 1½ to 2 cwt., this would amount to 2 or 3 tons per day per million gallons of matter which, inspecting it lately at Sutton, I found to consist mainly of paper, lumps of fæces, and vegetable residues, a mass requiring separate treatment.

From the screen the liquid passes on to the top of pits filled with coarse ballast, called variously "bacteria tanks" or "coarse filters," analogous to the "roughing filters" of former systems, but differing from them in the intention not only to remove solid matter, but to alter it bacterially. The effluent, now greatly improved, is distributed by channels over fine beds of coke-breeze, whence it issues at intervals as a liquid usually clear and deprived of offensive character.

"Sutton" or "Dibdin" beds have been adopted in a large number of places. At Manchester, experimental filter beds

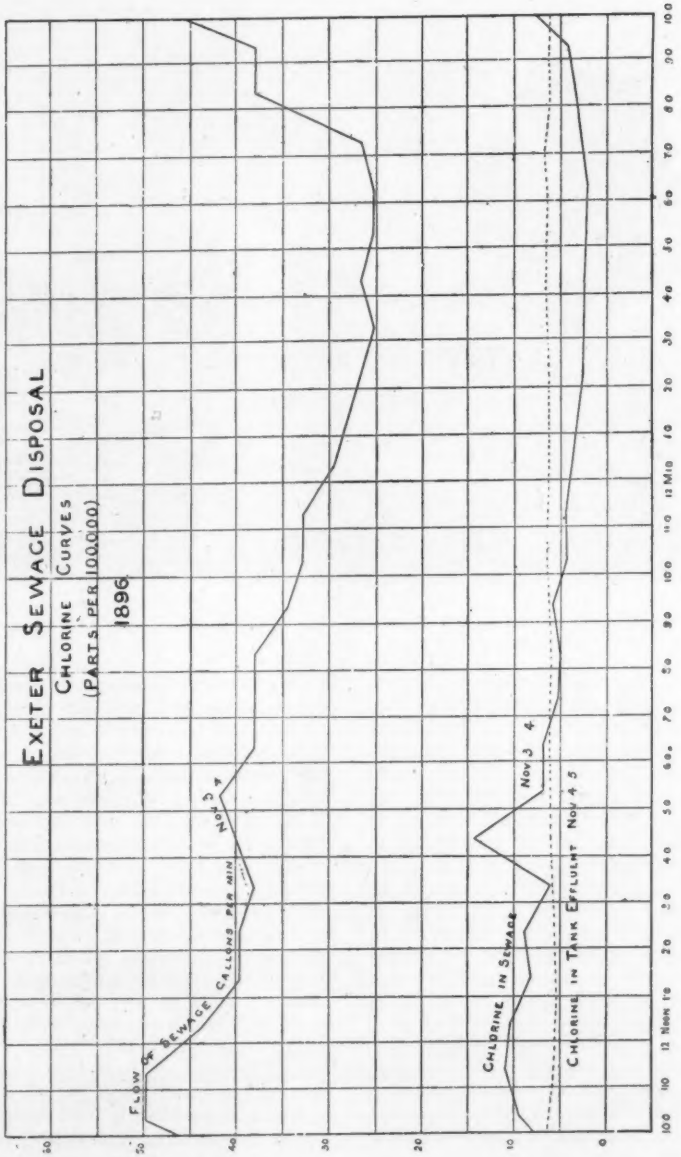


FIG. 5.—DIAGRAM SHEWING THE SMOOTHING EFFECT OF A SEPTIC TANK AS MEASURED BY THE CHLORINE IN THE SEWAGE AND EFFLUENT.

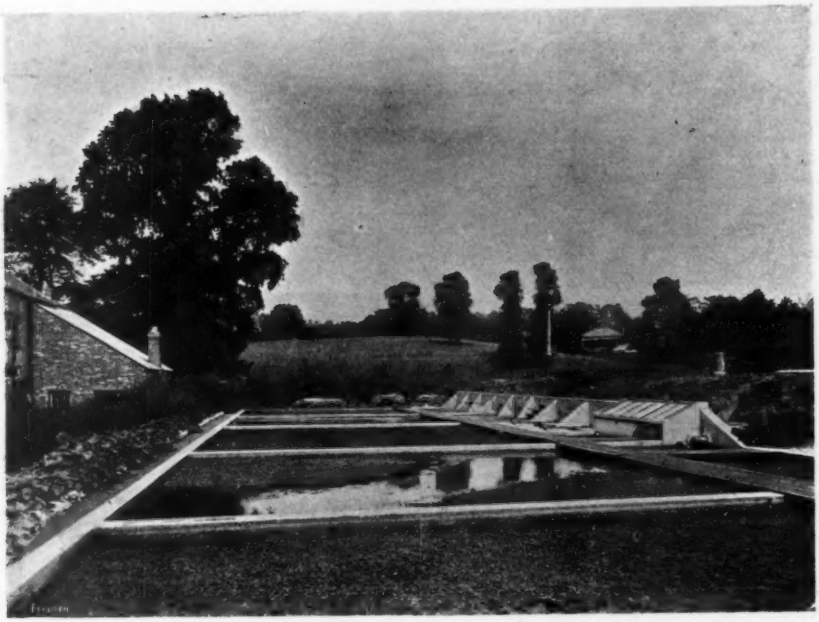


FIG. 6.—BELLE ISLE SEPTIC TANK AND FILTER BEDS, EXETER, SHEWING WELSBACH LAMP LIT BY GASES.

worked on the same principle have been named "double contact" beds. In connection with a recent inquiry at Newmarket, I was asked to make a special examination of the Sutton results for the Local Government Board, and through the kindness of Mr. Metcalf, the Surveyor at Newmarket, I am able to give a diagram prepared by him from my analysis (p. 7). I found the average purification to be 81 per cent. on the screened sewage, as measured by the oxygen consumed, or 82 to 83 per cent. by the nitrogen oxidized. The previous mechanical removal of a portion of the solids to avoid the clogging of the coarse filters is a complication avoided in other bacterial systems.

It will be seen that up to quite recently the idea that *anaerobes*, or bacteria acting independently of oxygen, effected the first changes in the resolution of organic effete matters, by causing *hydrolysis*, or combination with water, so as to liquefy the solid substances and occasion a general breaking up of the molecules into simpler compounds, had been overlooked. After this decomposition a second class of bacteria, the *aerobes*, acting in conjunction with air, effect a further simplification, the end being reached by the *nitrifying organisms*, which, in an ideal system, completely "mineralize" the product, leaving only nitrates, carbonic acid, and water. These were the three natural stages attained by the successive working of three distinct classes of organisms, which were most healthy and vigorous under different conditions: hence the aim should be to allow each its province separately without avoidable disturbance. The reason why the first anaerobic or hydrolytic stage had been either insufficiently provided for, or deliberately avoided, was the fear of the name of putrefaction, and the generation of gases that had more or less odour. In practice, however, it was found that the

process could be easily conducted without danger or inconvenience. Moreover, an engineering advantage of anaerobic tanks is that they do not require any fall, as the sewage enters and leaves such a tank at the same level.

This was first accomplished by Scott-Moncrieff in his "bacterial tank" at Ashtead, in 1891, in which the fresh sewage gradually passed upwards through an anaerobic bed formed of stones, with the result that great liquefaction was attained. In 1895, Mr. Cameron, the City Surveyor of Exeter, after many experiments leading him to discard stones or other obstructions to the flow, as occupying unnecessary space, inaugurated at Belle Isle, Exeter, the "Septic Tank" system.

The tank is a closed chamber of cemented bricks. The raw sewage, without screening or preparation of any kind, runs into a small section divided off by a brick partition coming to within about 1 ft. of the surface, where in this "grit chamber" it deposits stones, gravel, and earthy matters not requiring purification. The organic solids float or remain suspended and pass on into the body of the tank. In this closed space it remains almost quiescent, subject to the vigorous action of bacteria, which must be at least

SEPTIC TANK FILTRATION.

Cycle for four filters, Nos. 1, 2, 3 and 4, discharging into four Collective Wells, A, B, C and D.

At starting 'et filter No. 4 be already full and resting, and No. 1 filling. Period I.

When No. 1 fills it overflows into tipper C, discharging No. 4, putting down outlet valve of No. 3, and admitting effluent to No. 3. Introducing Period II.

When No. 3 fills it overflows into tipper B, discharging No. 1, putting down outlet valve of No. 2, and admitting effluent to No. 2. Introducing Period III.

When No. 2 fills it overflows into tipper D, discharging No. 3, putting down outlet valve of No. 4, and admitting effluent to No. 4. Introducing Period IV.

When No. 4 fills it overflows into tipper A, discharging No. 2, putting down outlet valve of No. 1, and admitting effluent to No. 1. And so on.

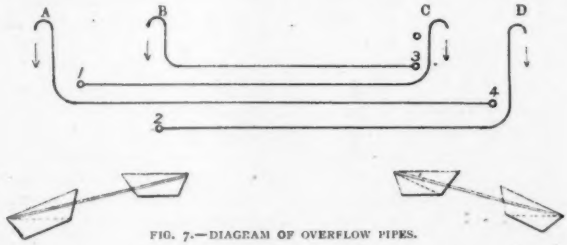
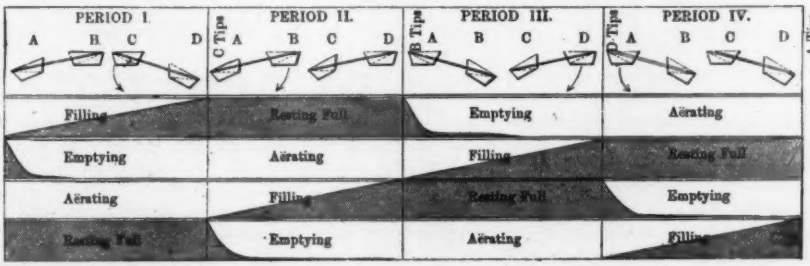


FIG. 7.—DIAGRAM OF OVERFLOW PIPES.



A=Position of Gear; B=Filter No. 1; C=Filter No. 2; D=Filter No. 3; E=Filter No. 4.

FIG. 7A.

DIAGRAM SHOWING SUCCESSIVE STATES OF FILTERS, CORRESPONDING TO SUCCESSIVE POSITIONS OF ALTERNATING GEAR.

potentially anaerobic as air is practically absent. A scum forms at the top, through which bubbles of gas are continually evolved, from the sediment of earthy character at the bottom; beyond this the solids are liquefied and dissolved in the fluid, which issues slowly from a slotted pipe at the far end. The capacity should be regulated so that the sewage travels at the rate of two or three feet per hour.

I have already said that sewage varies. But the result of such a mixing and decomposition as the above is that the liquid emerging is fairly uniform in character. The smoothing effect is illustrated in the annexed diagram prepared from analyses by the late Mr. Perkin, of Exeter. After issuing from the tank the liquid is ready for the next change, that of partial oxidation.

In several respects the anaerobic breaking down of organic refuse is similar to the action that occurs in the retorts in the manufacture of coal gas. The principal products, free hydrogen and methane, are the same; in fact the latter (methane, CH_4) has been called "marsh gas" from its being produced in stagnant pools where anaerobic changes occurred beneath the surface. At Exeter I found the atmosphere of the septic tank to contain in per cents., hydrogen 36·4, methane 24·4, nitrogen 28·6, carbonic acid 0·6, and a mere trace of oxygen. The mixture burns with a blue flame, giving great heat, which can either be utilised under boilers, or by means of incandescent mantles be applied to the lighting of the works. The latter course has been pursued at Exeter, and in the illustration, Fig. 6, the lamp in the centre distance is fed by the gases from the septic tank.

The available gaseous energy can be roughly calculated from the consideration that the organic matter removed from the sewage and converted into gas in the tank is for the most part not oxidised or burnt therein. The oxygen-consumed figure therefore of the raw sewage, with its suspended matter, less the oxygen-consumed figure of the tank effluent, gives a measure of the combustibility of the gases produced.

In this way the anaerobic bacteria quietly disintegrate and dissolve the solid matters in a closed space without apparatus or attention or smell. Beyond the simplicity, the chief advantages claimed by this system are the non-production of sludge, and the preparation of a tank effluent in a state of transition fit for either irrigation or filtration. It is evident that, short of the loss occasioned by the gaseous changes, the solution of the solids will often result in a liquid containing more dissolved organic matter than the original sewage, but in a further advanced and tractable state.

At Exeter the tank effluent, which of course is at this stage anaerobic, or devoid of oxygen, is next supplied with it by trickling over a simple aërator. It then flows through distributing channels on to the top of beds corresponding to the second or "fine filters" of the Dibdin system. The periods of "filling," "resting full," "emptying," and "resting empty," alluded to in the Barking case, are secured by Mr. Cameron's "Automatic Gear" (Figs. 7 and 7A), which works day and night without attention, thereby securing great economy, the only drawback being, as Mr. Mansergh, in his Baltimore report, has pointed out, that the slow filling of a filter at night time unduly prolongs the "resting full" period of a day filter.

Having been conditionally approved by the Local Government Board at the Exeter enquiry in November, 1897, the Cameron system is in course of extension to the sewage system of the whole of that city.

Other works are in operation in various localities. Fig. 8 shows the installation at the Styal Cottage Homes, near Manchester.

Recent large works at Barrhead, near Glasgow, are designed for a population of 10,000 and a maximum flow of sewage and storm water of 400,000 gallons per day, with provision for dealing with much larger exceptional quantities. There are two grit chambers, four septic tanks, and eight aërating bacterial filters, the whole built in concrete. Each of the tanks is 100 ft. long by 18 ft. wide, and 7 ft. deep at low water, roofed by concrete arches on rolled steel joists with brick piers.

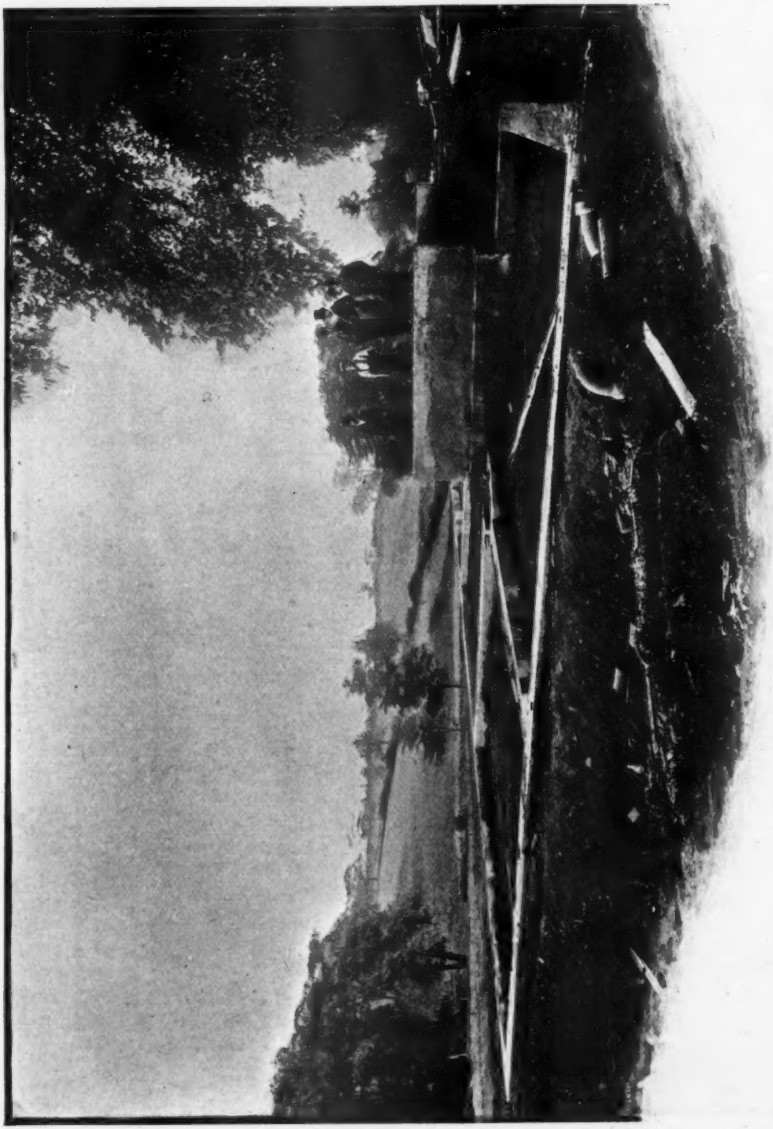


FIG. 3.—SEPTIC TANK AND FILTERS AT STYAL COTTAGE HOMES, NEAR MANCHESTER.

FIG. 9.—VIEW OF BARRHEAD SEWAGE WORKS, NEAR GLASGOW: SEPTIC TANK SYSTEM.

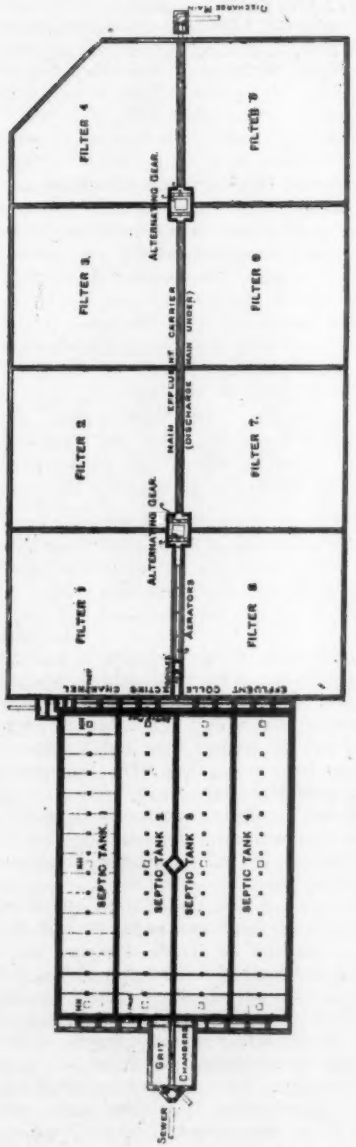


FIG. 10.—PLAN OF SEPTIC TANK AND FILTER AT BARRHEAD, NEAR GLASGOW.

The dry-weather capacity of the four is 312,500 gallons, but in periods of storm allowance is made for a rise of 18 ins., or an additional capacity of 70,000 gallons, the flow to the filters being maintained constant by two controlling modules. Each filter is 55 by 54 ft. in area, with 4 ft. depth of broken furnace clinker; total filtering area 2540 sq. yds. (Figs. 9 and 10). Two of the eight filters are usually kept in reserve. The practical working is the same as that at Exeter, and is thus described:—

"The tank effluent is supplied to one filter at a time, and is distributed over the surface of the filtering material by a system of stoneware distributing channels laid thereon. The discharge valve is closed meanwhile, so that the interstices of the filtering material become filled with the tank effluent. The effluent remains in the filters for about one hour and a half, during which the dissolved impurities are oxidised by the bacteria attached to the filtering medium. The discharge valve is then opened, when the filtered effluent escapes, drawing down after it a supply of air into every crevice of the filter. The latter is then left to drain and aërate while the other working filters are filled in turn, after which it is again filled. This method of working renders the filters self-cleansing, so that they retain their purifying power unimpaired. The opening and closing of the admission and discharge valves are automatically effected by the overflow of a small quantity of filtered effluent. These operations, therefore, go on continuously without the intervention of manual labour."

(*To be continued.*)

Samuel Rideal

Arbitration in Labour Disputes.

By GEORGE HOWELL, F.S.S.

MR. GEORGE HOWELL, the son of a builder and contractor, was born in 1833. He was an actual working man during more than twenty years, but more recently important public work has claimed his attention. He contested the Borough and Hundreds of Aylesbury in 1868, and again in 1874, and Stafford in 1881. He was eventually elected for the Bethnal Green North East Division in 1885, and he devoted himself in Parliament to questions more or less his own, such as London Government, Charity Administration, the Amendment of Saving Banks Laws, etc. His wide experience has fitted him to be a shrewd critic and an able exponent of all questions connected with labour.

ARBITRATION in relation to labour, and arbitration in matters relating to commerce and trade, require to be dealt with on quite different lines as the law now stands, as will be shown further on. The law will have to be materially changed before what is called legal arbitration can be applied to labour disputes. A brief historical outline of the subject is first needed in order to see precisely where we stand.

Great progress has been made in favour of the principle of conciliation and arbitration in labour disputes during the last thirty years, not only as regards its policy as a principle, but in its application as a means of averting strikes and lockouts, and in settling labour disputes when they arise. Forty years ago, that is, during the great strike and lockout in the building trades in 1859, partially continued throughout 1860 and into 1861, it was very difficult to obtain an interview with any of the Master Builders engaged in that struggle, most of them refusing to see and treat with the accredited labour leaders of that day. In some half-a-dozen instances, in which an interview was obtained, the leaders were rudely treated, and in two cases they were threatened with ejectment from the office. One of these two employers afterwards became a most consistent and generous advocate of conciliation, his influence being always in favour of peace.

In spite of the then unwillingness of employers to meet and negotiate with the representatives of Trade Unions, there was a softening down of that feeling ere the dispute was finally settled. During the next ten years some practical progress was made, but not very much. The feeling, or sentiment, in favour of conciliation grew, however, and approval was more pronounced. Unfortunately this was, for a time, checked by the Sheffield outrages, resulting in an "Inquiry into the Rules and Organisation of Trade

Unions." That "inquiry" cleared the atmosphere, the final report being much more favourable to trade combinations than the labour leaders and their friends expected, or could have hoped for, in the then state of public opinion.

The movement in favour of Boards of Conciliation and Arbitration was due to a study of the conduct and results of the legal tribunals in France, called the "conseils des prud'hommes," first established at the beginning of the present century, an effort to imitate which was made by Mr. Mackinnon in Parliament ere the close of the first half of this century. But his efforts failed, although supported by a workmen's association.

Among the earlier efforts to create voluntary boards for dealing with labour disputes was one at Macclesfield, in 1849, called "The Macclesfield Silk Trade Board." It lasted but four years, and at its dissolution strikes again became frequent. It is worthy of note that the Board was broken up through an employer refusing to be bound by the rules, which the men tried to enforce by a strike, but the Board was not reconstituted, though it had done much good during its brief existence.

The first really effective Board of Conciliation was established in the hosiery trade, at Nottingham, mainly due to the efforts of the late A. J. Mundella, in 1860. There had been three strikes in that year in one branch alone, and the manufacturers met to decide upon a lock-out in all branches. Mr. Mundella and two other employers met the workmen's representatives, with the result that a lock-out was averted and a Board of Conciliation was instituted. That Board became permanent. In 1865 the late Sir Rupert Kettle established a similar Board at Wolverhampton, but that subsequently broke up, in this case mainly by the action of the workmen.

The most important of these earlier Boards was constituted in 1869, in the manufactured iron trade—a trade in which strikes were frequent, often attended by violence, sometimes by the calling out of the military. Early in 1869 the iron trade improved, and the operatives made a demand for higher wages. Instead of at once resorting to a strike, the men, under the influence of the late John Kane, the then Secretary of the Ironworkers' Association, sought a conference with the employers. Mr. Kane had directed inquiries to be made into the working of the Hosiery Board at Nottingham, with the result that a meeting of the men was held to obtain their sanction: then a conference was held of both parties, when it was agreed to establish such a Board; rules were drawn up, and a permanent scheme was adopted. That Board has been in existence ever since, without a break, and is now called "The Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England," which trade is governed by a sliding scale of net prices and wages.

All the schemes referred to, and others not mentioned, are based on the voluntary principle, both as to the submission and as to the enforcement of the awards. In the old Guild system there was practically enforced submission, and the Guild could enforce the award. When the Guilds were dissolved no provision was made as to arbitration, not even by the 5 Eliz. c. 4. Cases were relegated to the Justices under that statute called the "Statute of Apprentices," but in reality it applied to all workmen. All subsequent Acts on the subject were of the same character. Workpeople were under the Masters and Servants Acts, combinations being prohibited, until the repeal of the Combination Acts in 1824, and finally in 1825. There was an apparent departure from the usual system, under what is called the Spitalfields Acts, the 13 Geo. III. c. 68, in 1773; the 32 Geo. III. c. 44, in 1792; and the 51 Geo. III. c. 7, in 1811. Those Acts specifically provided for Arbitration before the Justices, more or less in the nature of civil cases—but the Masters and Servants Acts also applied, so that the arbitration clauses were practically of no avail, so far as workmen were concerned.

The first real Arbitration Act was the 5 Geo. IV. c. 96, passed in 1824. It repealed all other Acts, or portions of Acts, which were then unrepealed, and substituted in lieu thereof "An Act to Consoli-

date and Amend the Laws relating to the Arbitration of Disputes between Masters and Workmen." This still remains the principal Act in force. But its provisions have never been put in force from the day of its enactment until now. The reason is obvious to those who have really studied the question from a legal point of view—that Act made it impossible to settle labour disputes under its provisions, not by any defect in its draughting or construction, but by its essential principles; the authors of its being murdered it at its birth. It never was operative, could not be operative for any useful purpose, whatever its object.

The whole Act is vitiated by the latter part of s. 2, which says: "Nothing in this Act contained shall authorise any justice or justices, acting as hereafter mentioned, to establish a rate of wages or a price of labour or workmanship at which workmen shall in future be paid, unless with the consent of both master and workmen." If not establish future wages, what can be done in labour disputes? The Council of Conciliation Act, 1867, confined itself to the same provisions, all the sections being subject to the Act of 1824. The Act of 1867 was promoted by the National Consolidation of Trades, and was supported by the London Trades Council. Lord St. Leonards took charge of and carried the measure. Like the former Act, it has never been put in force. It provided for the establishing of permanent courts in all industrial centres. But the action was to be purely voluntary.

At the second Trades Union Congress, held in Birmingham in 1869, a strong feeling was expressed in favour of Conciliation and Arbitration, and the resolution proposed was carried with very few dissentients: the chief opposition to it came from the Wolverhampton delegates of the building trades, who had found fault with some decision or award in that town. Similar resolutions were carried at the two next congresses in London and Nottingham, and in 1872 a Bill was prepared under the auspices of the Parliamentary committee, and was carried in that Session as "The Arbitration (Masters and Workmen) Act, 1872." That Act would have been all right except for the Act of 1824, which, in effect, nullified it. This Act, like the others, has never been operative in any sense or case. The three Acts mentioned, and the Hosiery Act, 1874, are still "in force," though inoperative—as dead in fact as Queen Anne.

The position was materially changed by the Employers and Workmen Act, 1875, when the old Master and Servants Acts were repealed, and labour contracts were made civil contracts as in all other cases. In 1894, Mr. Mundella introduced a Bill somewhat similar to the Bill of Mr. Ritchie in 1896, which is now the only operative Act. Mr. Mundella endeavoured to attach to his measure the Arbitration Act of 1889, but the latter Act is no more applicable to labour disputes than the Mutiny Act. Mr. Mundella failed to carry his Bill, but, shorn of the provisions of the 1889 Act, and modified in some other particulars, the measure was subsequently carried, all the previous Acts being, however, still unrepealed. It is necessary that the foregoing particulars shall be known, in order to see where we are, and the muddle we are in as regards arbitration in its application to labour disputes.

The Arbitration Act, 1889, is an excellent Act for the purposes for which it was designed, namely, arbitration in matters of business, commercial and trading. In all such cases the dispute has reference to something done, or not done, in respect of contracts, the breach of which can be measured in value, or the fulfilment of which can be enforced. It is mostly a matter of account, the details of which are adjudged to be too complicated for the High Court of Justice. The judge can order any such case to be referred to arbitration. The important difference between a business transaction and a labour dispute is this: The aggrieved party in trade and commerce sues for the fulfilment of a contract, or for damages for the breach thereof. The entire transaction is present or past; its only relation to the future is the award, whether in the shape of damages, or in the enforcement of the contract, with penalties for non-fulfilment. The offence, whatever it is, can be expressed in money value, and be

recovered in the usual way. The future is only incidentally included or touched upon; only, indeed, in the sense of obeying the decision of the court, for all the matters have reference at this stage to the past.

In labour disputes there is practically no past, and only incidentally a present, the whole matter relates to the future, whether it be a question of wages, hours of labour, or conditions of employment; and yet the Act of 1824 says that the future rates of wages, etc., shall not be fixed. What then can arbitration in such a case do? If future rates of wages are not to be fixed, neither can hours of labour, nor other conditions. A labour dispute is always about some present thing, whatever that thing may be; but the object of the dispute is in relation to the future, which future only begins when the dispute is ended, in whatever way the settlement may be effected. It is obvious, therefore, that before legal arbitration in labour disputes can be acted upon and carried out, the Act of 1824 must be repealed, or be rendered nugatory by some further Act, becoming in the latter case obsolete. It is now a stumbling-block and a hindrance, and perpetuates the false notion that the future rates of wages are not to be fixed by such means.

Some of the labour leaders of the present day advocate compulsory arbitration, a considerable proportion of the delegates at the late Congress voting for it. They surely do not quite understand what it means. Do they desire to see a law passed and enforced to compel an employer, whether he wills it or not, to expose his books, prices, names of customers, and disclose other matters to a board or to an umpire? Do they imagine that any trade union, with perhaps from ten to eighty thousand members, would agree to compulsory arbitration, which might in the end affect the majority of them, because a dispute arose affecting fifty or a hundred? Compulsory submission would be resented and resisted in ninety cases, at least, out of a hundred. Neither employers nor employed could be expected to submit to such compulsion, nor can it be carried into effect. Submission must be voluntary on both sides.

But there is another and a more practical side to this question. After voluntary submission, an agreement to submit the matters in dispute to a tribunal, however constituted, ought not the law to be called in to enforce the award, whenever circumstances require it? Upon this point there is great difference of opinion, and much difficulty. The difficulty can only be got over by a full and complete recognition of the principle of collective contracts, the trade union being held responsible for any breach of an award, or non-fulfilment of the contract, expressed or implied; for an implied contract, if proven, is as good in law as an expressed or written contract. To be effective, the law of contract in respect of labour disputes must be strengthened, so as to be able to enforce obedience upon each individual member of an association, in cases where submission to arbitration is voluntarily made, to fulfil the conditions of the award, or be mulcted in damages for any breach thereof.

Submission to arbitration by legal compulsion is clearly out of question at present, whatever may be its future. Legal enforcement might be tenderly applied, if both parties could agree to statutory provisions for enforcement when voluntary submission had been mutually agreed upon. But the needful legal machinery for enforcing an award does not exist at present, except in the crude form of the Employers and Workmen Act, 1875, and then only when specific notice is required. Fewer difficulties exist in respect of voluntary arbitration, and those that do exist are being surmounted, for the present the law is in its favour. The Act of 1896 gives power to the Board of Trade to promote conciliation, and to endeavour to bring the parties together with that object. There is also the further power to interfere if one of the parties require the Board to act. But this has not been really acted upon, the experiment is too dangerous.

Meanwhile, Conciliation and Arbitration in labour disputes have advanced rapidly. The experimental stage has long been passed. As a policy it has been successful. The North of England Board has

existed without a break for thirty years, and is believed in by employers and employed. A similar Board exists in the Midlands, called the "Midlands Wages Board." More recently a Board has been constituted in the Scottish iron trade. The iron and steel trades are governed by a sliding scale, based on net selling prices per ton. The same principle has been in operation in the South Wales and Monmouthshire coal trade, but in this case there has been less satisfaction, notice having been given to terminate the scale. In the coal districts the sliding scale arrangement has not at all times worked satisfactorily, but the trade is still governed by a policy of conciliation.

The Joint Board in connection with the Boot and Shoe trade, instituted under the auspices of the Board of Trade, has practically solved the question of enforcement of awards by the deposit of a large sum to be drawn upon as smart money, in case the men refuse to be bound by the agreement. In a recent case the Union had to pay £300, and the men had to submit to the Conciliation Board. The fine was, perhaps, inadequate; but the fact that the Union did its best to compel the London section to submit was doubtless taken into consideration. This mode of procedure can only be made effective where collective bargaining is fully recognised. In the coal districts, especially in Wales, fines are constantly imposed by the Courts for breaches of time agreements, by absenting themselves from work without due notice.

Voluntary conciliation is gaining ground. It is more or less effective in the textile trades of Lancashire, in the tailoring trade, in the building trades, in the engineering trades, and in numerous other industries. In a great number of instances it has been resorted to of late, as occasion has arisen, under the Board of Trade, under the auspices of the London Chamber of Commerce, or under local influence. There is a wholesome tendency towards peaceful methods of settlement. Employers no longer refuse to meet the men's representatives as they once did, and the men have less suspicion than they had. Any hasty attempt to substitute compulsion, even as regards enforcement of awards, may arrest the course of the stream in favour of conciliation and arbitration, instead of facilitating it. Strikes and lock-outs are costly; they cause suffering, and embitter the relations between Capital and Labour. They can only be averted by mutual forbearance and by negotiation. In whatever way they can be averted, or settled when they occur, deserves commendation.

Sir George Howell.

Modern Appliances in Gas Manufacture.

By G. E. STEVENSON, M.I.C.E.

PART II.—INCLINED RETORTS, &c.

(*Continued from Vol. 1, page 573.*)

THE mechanism for charging the retorts is as follows:—To the bottom of each conical pocket depending from the continuous bunker is attached a measuring chamber, something like a powder flask. A valve, or slide, is interposed between the measuring chamber and the conical pocket, and another valve, or slide, is fixed at the lower end of the measuring chamber.

FIG. 19.—AUTOMATIC PLANT FOR CONVEYING COAL TO THE INCLINED RETORTS AT THE GAYTHORNE WORKS, MANCHESTER.

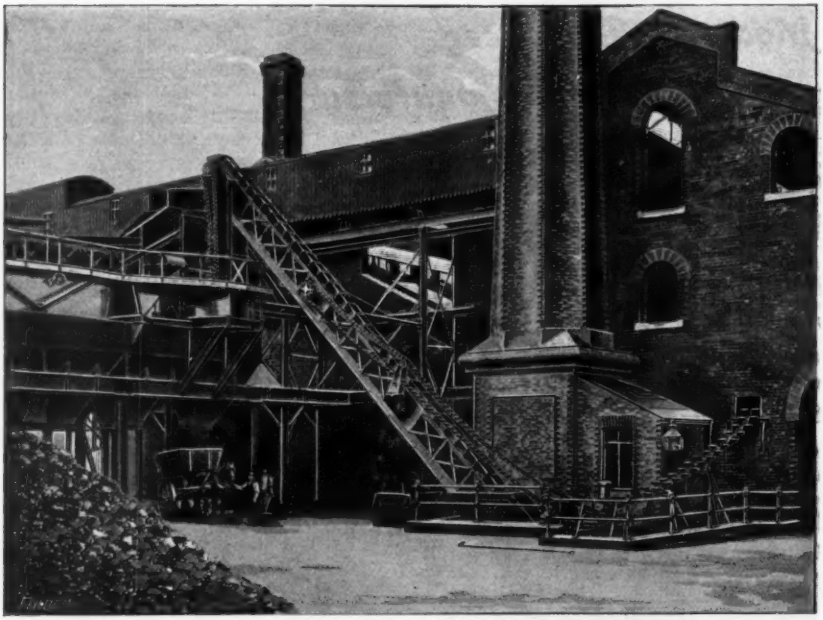


FIG. 20.—INSTALLATION OF COKE-HANDLING MACHINERY, SHOWING END OF HOT COKE-CONVEYOR AS IT LEAVES THE RETORT HOUSE AND DELIVERS THE COKE TO AN ELEVATOR SCREEN AND OVERHEAD CONVEYOR.

These slides are actuated by levers, suspended from brackets and rods, the levers for filling the chambers being placed at the back of the charging stage, and those for charging the retorts at the front, next the retort bench.

Each chamber contains, when filled, one charge, the weight of which can be varied by an adjustable baffle-plate to from 5 cwts to 7 cwts. of coal. For charging the retorts shoots of square section are used, which are provided at the top end with funnels and travelling carriages, the carriages running on light rails. At the bottom end is attached a shoe, which can be adjusted to enter the mouthpiece of the retort. The shoots are of three different lengths, corresponding to the three rows of retorts. When a retort is to be charged, the shoe is placed in position with its lip just inside the retort mouthpiece. The slide at the bottom of the measuring chamber is then opened by the attendant, at first partially, and then, as the coal begins to creep up the retort, more fully, until the whole charge has entered the retort. The first portion of the charge slides down to the lower end of the retort, and, coming in contact with a "stop" inserted into the lower mouthpiece, is arrested. The succeeding portions of the charge are arrested by the coal already deposited in the retort, and, if the operation has been carefully performed, the result is that a continuous layer of coal of uniform thickness is deposited on the floor of the retort. The charging stage is fixed at such a level that the mouthpieces of the lowest retorts are just above it, and those of the uppermost retorts are easily accessible to the attendants. The charging of a retort occupies half a minute.

In discharging the retorts at the lower end, the retort man, after opening the mouthpiece door, or "lid," removes the

"stop." If the charge is very thoroughly carbonized the coke may at once commence to slide out. More usually it is necessary to slightly stir the end of the heap of coke with a poker before the movement will commence, on account of the sticky effect of the tar which has condensed under the ascension pipe. Provided the charge is evenly distributed and well burnt off, the coke, once set in motion, will pour out in one continuous stream, and the retort will be discharged in half the time it takes to charge it.

COKE-CONVEYING PLANT.

Similar installations of inclined retorts have been constructed at many gas works during the past half-dozen years, though few have been provided with so completely automatic a coal-conveying plant.

At Manchester, however, a fresh departure has been made in the addition of machinery for removing the coke from the retort house.

The problem to be solved was the immediate removal from in front of each retort, as it is discharged, of 4½ cwt. of coke, falling out of the retort in 15 seconds of time. It was necessary to provide a conveyor of sufficient capacity to receive the heaps of coke, and travelling at such a speed as to convey the coke out of the way of the retort men without delaying them in their work. There was also the operation of conducting the coke to the store heap in the yard to be considered. Coke conveyors had previously been applied at the Birmingham Gas Works and in a few other works of less magnitude, but in these instances the coke was discharged from horizontal retorts in small quantities at a time, either by the drawing machine or the hand rake.

A new type of conveyor was designed for the Manchester installation, and constructed by West's Gas Improvement Company with the approval of the author. This conveyor consists of a cast-iron trough, 24 inches wide by 9 inches deep, in which an endless chain travels on a central rail. The chain is composed of cast-steel links bolted together, and on each alternate pair of links are cast blades, or propellors, which match the section of the trough, but do not touch the sides or bottom of it. Between the links containing the propellors are placed slide blocks, which slide on the rail and support the chain links and propellors free of the rail and trough. The pins uniting the links are covered by loose sleeves, or rollers, a patent of Mr. Charles Hunt, C.E., of Birmingham, the purpose of these rollers being to minimise the friction and wear in passing round the sprocket wheels. The

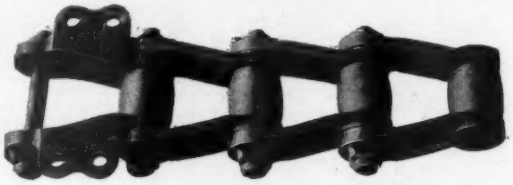


FIG. 21.—HUNT'S PATENT CHAIN USED IN NEW TYPE OF CONVEYOR.

FIG. 22.—NEW TYPE OF CONVEYOR, DESIGNED FOR MANCHESTER INSTALLATION.

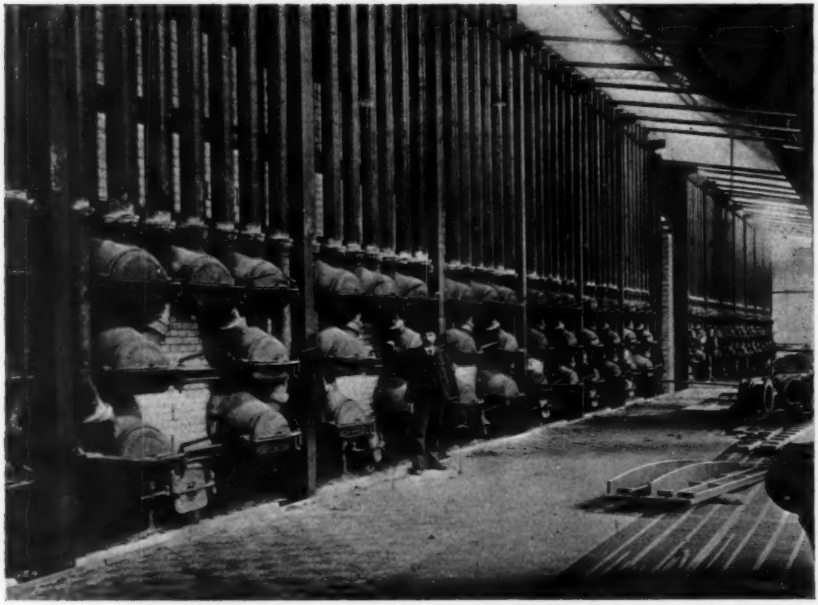


FIG. 23.—INCLINED RETORTS: DRAWING STAGE, MEADOW LANE WORKS, LEEDS.

conveyor extends the whole length of the retort house, and after passing out at one end, and arriving at the elevator shoot, the chain returns over-head on rollers and sprocket-wheels carried on brackets secured to the upright supports of the retort bench. The elevator raises the coke after it is brought out of the retort house to a moving screen fixed above the storage hoppers. The elevator differs from the ordinary kind in having the buckets placed close together and mounted on wheels. A shoot conducts the coke into the elevator buckets, and is so arranged as to prevent the coke falling between the buckets into the pit. The screen at the top separates the dust, or "breeze," from the coke and delivers the latter on a "plate" conveyor of ordinary construction, by which it is carried to the store heap. A series of ploughs is arranged along this conveyor, by which, when any one of them is lowered to within an inch of the plates, the coke is thrown off and falls on the heap.

The principal difficulties met with in the mechanical handling of coke are: rapid wear of the parts of the machinery, owing to grit from the coke; excessive friction, causing undue strain on the machinery; destruction of the parts, through contact with hot coke; and deterioration of the coke, through the tumbling motion imparted to it. In the conveyor at the Gaythorn Gas Works, Manchester, these difficulties have been successfully combated. The chain in the trough conveyor works with a minimum of friction, as the only parts in contact are the sliding blocks and the rail. The parts being of cast steel are not affected by the heat of the coke, which, however, is quenched by copious streams of water immediately it falls into the conveyor. The coke does not tumble over, but slides along in the trough in a heap just as it falls from the retort.

ADVANTAGES OF THE INCLINED SYSTEM.

The advantages claimed for the inclined

system of retorts are: that it provides a means of carrying on the work of gas making without the necessity of heavy manual labour, that the system is equally applicable to operations on a large and a small scale, and that the labour expenses are less than with horizontal retorts. That the labour of charging and discharging inclined retorts is less severe than that of drawing or charging horizontal retorts by hand is obvious, but it is by no means so certain that in this respect the system is an improvement over machine stoking; nor has it yet been proved that the labour expenses are less than in the case of machine stoking, albeit in this respect also the system is in advance of hand stoking on horizontal retorts. The first cost of inclined retorts, with their attendant machinery, is high compared with horizontals.

Although some of the claims made on behalf of the new system may, perhaps, not be substantiated, its adoption is being rapidly extended. The reason for this is not far to seek. The labour difficulties of the present period are becoming more and more accentuated in respect of two items, viz., the amount of labour men are willing to undertake and the length of time they are willing to continue working. In manufacturing towns men are accustomed to watch machinery do the work, and they will always be more willing to move levers and turn hand-wheels rather than lift heavy weights, or incur in other ways great physical exertion. The time question is also an important one. Even under the *régime* of eight-hour shifts, the gas-stoker does not care to be kept working all the time. The speed with which inclined retorts are charged and emptied is of itself a great recommendation, permitting, as it does, of a much longer period of rest between each set of operations than under the old system.

As regards saving in wages, the mechanical handling of the coal and coke plays a very prominent, if not the most important, part. The abolition of coke

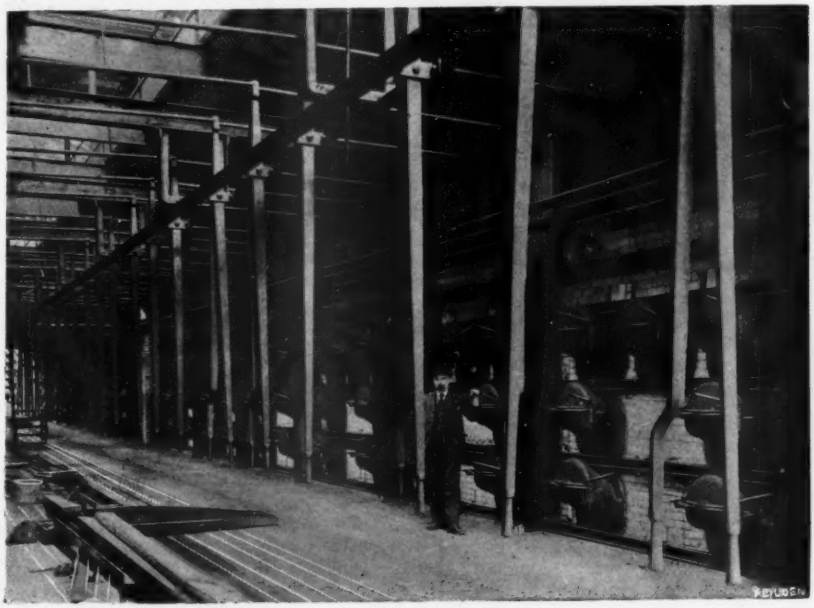


FIG. 24.—INCLINED RETORTS: CHARGING STAGE, MEADOW LANE WORKS, LEEDS.

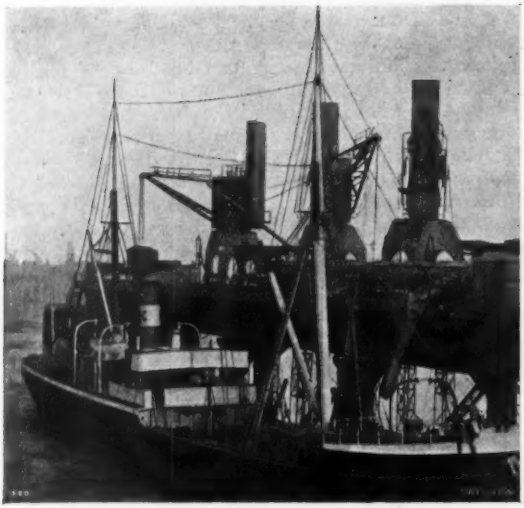


FIG. 25.—INSTALLATION OF HYDRAULIC CRANES AT THE GAS LIGHT AND COKE COMPANY'S PIER, BECKTON, FOR UNLOADING COAL.

FIG. 26.—CRANE USED IN THE MANCHESTER GAS WORKS FOR STACKING COKE.

wheelers alone, which the coke-conveying plant herein described accomplishes, results in a saving of nearly 5d. per ton of coal carbonized.

The inclined system of retorts was first adopted in its present improved form by the Brentford Gas Company, under Mr. Frank Morris, the engineer. This Company now manufactures gas entirely with inclined retorts, and their adoption has resulted in a marked reduction in the cost of manufacture. One of the earliest to adopt this system was Mr. George Winstanley, of Coventry. At Huddersfield, Mr. W. R. Herring introduced it. Mr. Herring, now chief engineer of the Edinburgh Gas Works, has decided to adopt the inclined system entirely at the new Edinburgh Gas Works, which he is about to construct. At Leeds, a large installation of this system has been constructed, comprising 28 retort settings, and further extensions are being carried out by Graham, Morton and Co., Leeds. A still larger installation is in course of construction at the Saltley Gas Works, Birmingham, the machinery in connection with which will be erected by the New Conveyor Co., of Smethwick.

The introduction of this system has given an impetus to the manufacture of conveyors and elevators, &c., for coal and coke, and there are several firms, notably Graham, Morton and Co., the New Conveyor Co. and West's Gas Improvement Co., which are devoting themselves very extensively

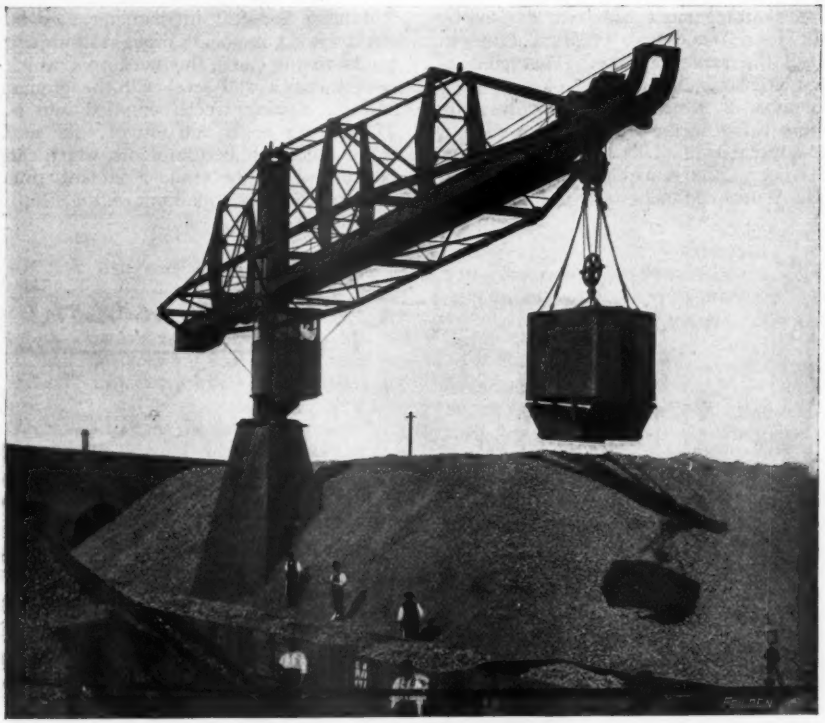


FIG. 27.—HYDRAULIC CRANE FOR STACKING AND LOADING COKE, SALTLEY WORKS, BIRMINGHAM.

to the improvement of appliances for this purpose. Several fire-brick manufacturers have turned their attention to making retorts specially designed for this system, and manufactured by machinery, amongst whom may be mentioned Messrs. B. Gibbons, Junr., of Dudley, and Messrs. Cliffe and Sons, of Wortley, near Leeds.

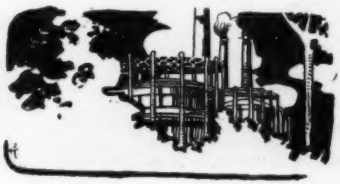
OTHER METHODS OF HANDLING COAL AND COKE.

Where coal or coke is required to be unloaded from vessels at a wharf, or stacked in large heaps, the use of cranes and grabs is common. A fine installation of hydraulic cranes is possessed by the Gas Light and Coke Co., at their new pier on the Thames at Beckton. Here some 4,000 tons of coal are unloaded from steamers daily, and placed in railway trucks to be conveyed either direct to the retort houses or placed in store in the yard. For stacking coal or coke in the yard, cranes with grabs are employed. This system has the advantage that the coal or coke may be removed from the heap by the same means by which it was placed there. Cranes are used at the Manchester Gas Works for stacking coke, and also for unloading coal wagons, the wagons being up-ended by the crane and the contents emptied into storage bunkers.

At the Saltley Works, Birmingham, the stacking of coke is performed by a hydraulic crane of large radius fixed centrally in the yard, the jib of which covers the whole area of the yard in its circuit. Recently

a new arrangement has been devised by Mr. John Woodward, of Manchester, to effect the same purpose. This consists in a circular gantry, or ring of girders on columns, on which a crane revolves, the crane being secured to a centre column by a radial arm. This coke-stacking plant has been erected at the Bradford Road Gas Works, Manchester. By means of it a heap 200 feet in diameter may be stacked, the coke being brought in tipping trucks to the crane, the bucket of which is sunk into a well level with the ground and the tipping trucks emptied into it. The bucket holds one ton of coke and is provided with bottom doors, which can be opened by the crane attendant, thus allowing the coke to fall out on the heap.

G. E. Stevenson



This instalment concludes that portion of the article written by the late MR. G. E. STEVENSON. The series will be continued by his brother, MR. FLETCHER W. STEVENSON.

Pneumatic Tools and Appliances.

By EWART C. AMOS, M.I.Mech.E.

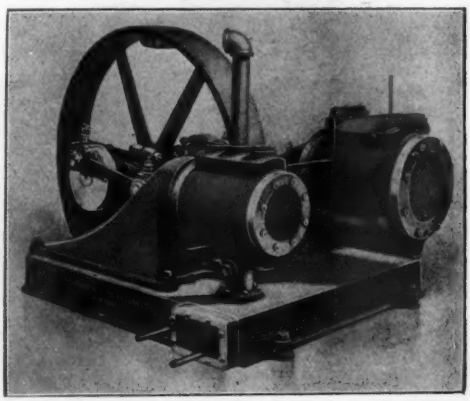
PART II.—AIR-COMPRESSORS.

(Continued from Vol. 1, p. 580.)

Since writing Part 1 of this series of Pneumatic Tools and Appliances, which appeared in the last issue of this Magazine, the author has found it necessary to somewhat depart from the lines of procedure which were therein set forth. It will be remembered that it was proposed to treat the subject under certain headings, and had that been carried out this present article would have commenced with a further consideration of pneumatic hammers, to be followed by a description of drills, &c., which have not yet been dealt with.

During the last few days, however, the author has come into possession of certain exclusive information in regard to both drills and hammers, which, however, it will not be possible to deal with until the March issue. It has therefore been deemed advisable to leave the further consideration of both these types of tools until then and to proceed with heading No. 4, which refers to air-compressors. It would, of course, have been preferable to have maintained the original idea, but, as was foreshadowed in the introductory remarks, so many new things in connection with Pneumatic Appliances are rapidly coming to the front, that it makes it difficult to obtain information of the latest; at the same time, as the particulars now being held back will doubtless prove of considerable interest, allowance will be made for the alteration.

Since pneumatic tools of the type under consideration are of no use for practical purposes without a supply of compressed air to drive them, it becomes necessary for every intending user who has not got an existing air-compressing plant, to put down an air-compressor, and therefore it will be useful to consider some of the types of compressors at present on the market. Here also the American engineers have shown themselves very prominent, and have for many years past sent over different types, and are still doing so. Whether their machines are better or even as good as our own manufacturers can turn out is very doubtful, but, with certain exceptions, they have laid themselves out to a greater extent than we have, and in the author's opinion there is a good opening for a British-built economical compressor suitable for driving pneumatic tools, for which there will soon be a large demand. The great hold which pneumatic-driven tools have taken on shipbuilders, and some of our railway and other leading engineers, is an indication that before long every firm



6.—"INGERSOLL-SERGEANT" COMPOUND BELT-DRIVEN COMPRESSOR.

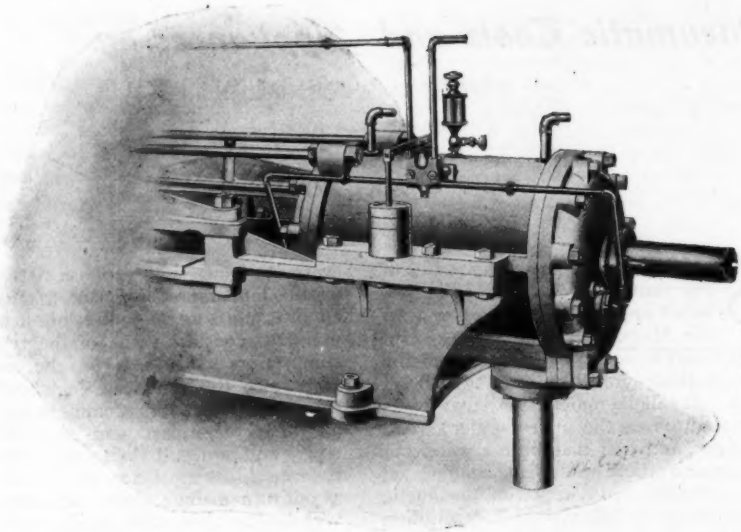


FIG. 7.—"INGERSOLL-SERGEANT" AUTOMATIC AIR REGULATOR AND UNLOADING DEVICE.

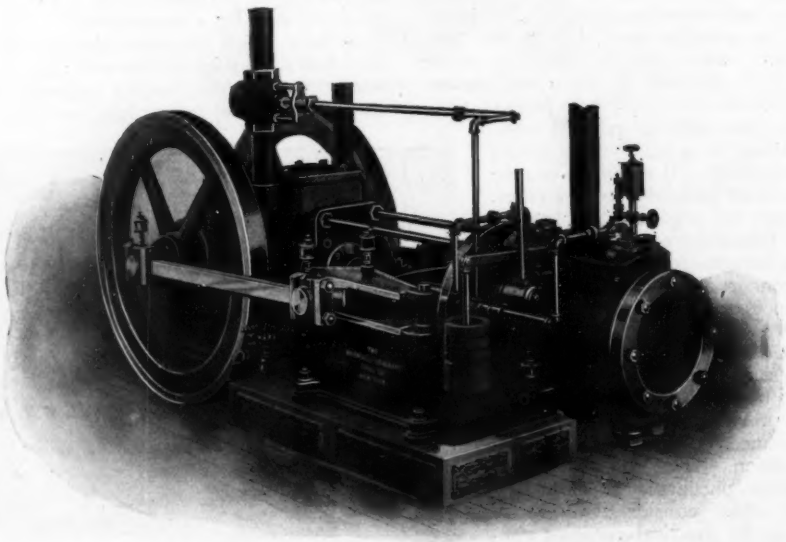


FIG. 8.—"INGERSOLL-SERGEANT" STRAIGHT-LINE COMPRESSOR.

who desires to be in the van of progress will be compelled to effect their adoption.

Air-compressors may be considered under two headings, viz. (1) belt-driven and (2) coupled direct to a steam or gasolene engine or electric motor. Each of these types, again, may be simple or compound, and reference will be made to all. Great as is the accuracy demanded in the construction of an efficient steam-engine, even greater care is called for in respect to air-compressors, as air will be found to leak through what is a fairly good steam-tight joint, and whilst in the one case the defect is readily apparent, in the other it may take place without being discovered, especially if not very great; at the same time, the loss becomes considerable when the leakage is continuous. It will readily be appreciated that cylinders, piston rings and valves must be constructed of the best material, and receive the best workmanship, especially where high pressures are used, and further that a good compressor must be simple in design and free from complicated parts likely to get out of order or cause trouble. Another point is that the valves should not stick, and that they should permit of the cylinder getting its full charges of air at each intake. The air, as is well known, is pumped into a receiver in order to secure an uniform pressure, and this receiver should not be less than 2 or 2½ times the capacity of the compressor in free air for one minute. It must also be provided with safety-valve, pressure-gauge, and draw-off pipe for water which is deposited from the air. Most compressors are fitted with an automatic regulator, or unloading device. This is found to be necessary to compensate for the amount of air being taken by the machines, which at certain times are not all in use, or may even all be stopped at once. To simply throttle the compressor down and blow off surplus air through a safety-valve would of course be wasteful, and it is the object of this controlling device to take the load off the compressor. In the case of a belt-driven compressor, it may take the form of a belt-shifter, automatically worked by the compressed air, or the inlet valve may be fitted with a governor, whilst another device provides for producing an equilibrium on either side of the working piston. Each of these systems will be referred to when describing the different compressors. There are at the present time a large number of air-compressors on the market,

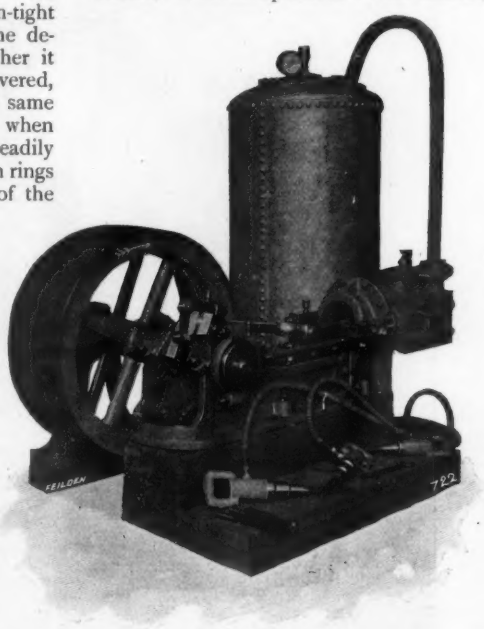


FIG. 9.—"ROSS" BELT-DRIVEN COMPRESSOR PLANT.

and it would be quite impossible to deal with anything like all of them in a series of articles such as these, but an endeavour will be made to treat of a few representative kinds of both British and American types which are suitable for driving pneumatic tools.

Coming now to a description of the illustrations given, Fig. 6 shows an "Ingersoll-Sergeant" Duplex Belt-driven Compressor, fitted with compound air

cylinders and intercooler in the base. The advantages of compounding are well known, especially where the pressure reaches 100 lbs. per sq. in. or over, and where the compressor is of any size, although in the smaller sizes the advantage from an economic point is not so apparent. When air is compressed right away in one cylinder to 100 lbs. per sq. in. a temperature of something like 500° Fah. perature of about 250° Fah., this being, of course, dependent upon the efficiency of the cooling jacket. The air is led through an intercooling chamber, where it is thoroughly cooled before entering the high-pressure cylinder, to be finally compressed to the desired amount. The resultant temperature is then much lower than when compressed from atmospheric pressure to the final pressure in one cylin-

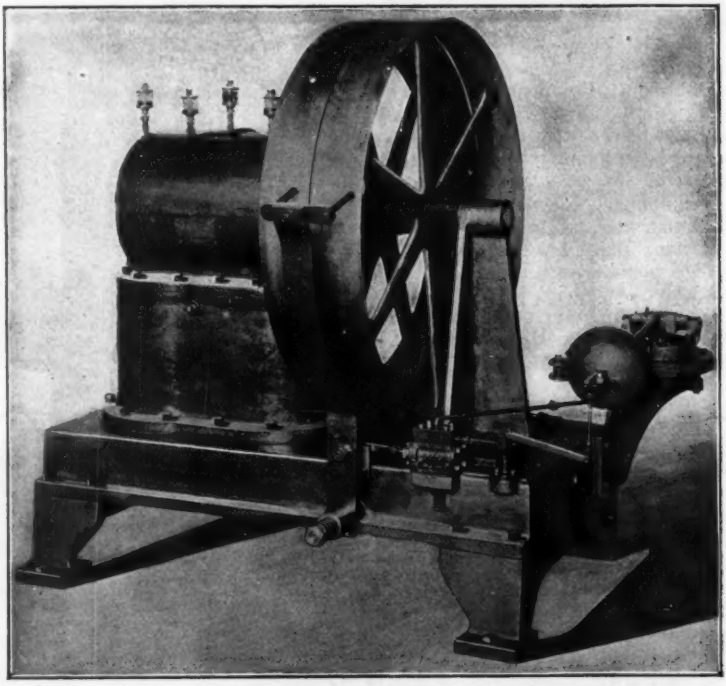


FIG. 10.—"PEDRICK AND AYER" COMPOUND BELT-DRIVEN COMPRESSOR.

results. Difficulties in respect to lubrication, valves, &c., naturally present themselves in continuous running, however good the cooling arrangement may be, and there is also danger from possible vaporisation of oil. Where, however, compounding is resorted to, the temperature is kept comparatively low, since the low-pressure cylinder only compresses its charge to about 30 lbs. per sq. in., which gives a resultant temder. There is also an appreciable economy, especially when dealing with large quantities of air, as the power required to compress is less when perfect cooling is attainable. In the compressor shown in Fig. 6, the intercooling chamber is made in the base-plate of the machine. In the next article, a sectional view will be given of the cylinder, both of Fig. 6, and also of a piston-inlet cylinder of the same make of

compressor, and it will be sufficient to say here it is of the double-acting type, having vertical-lift inlet valves at the bottom, with vertical-lift discharge valves at the top, leading into a common chamber, to which the delivery pipe is attached. The design and construction of the valves is such as to offer slight resistance and ample opening for the admission and expulsion of air, whilst the clearance space is very small. A further reference will be made to these when describing the illustration, where the top left-hand pipe is in connection with the receiver. As soon as the pressure in that rises beyond the normal working load, it lifts the weighted safety valve shown, and this immediately puts the two ends of the cylinder into communication; as soon, however, as the pressure falls, the valves close the connection, and the compressor resumes its work. In cases where the compressor is direct steam-driven, the steam supply is also automatically throttled

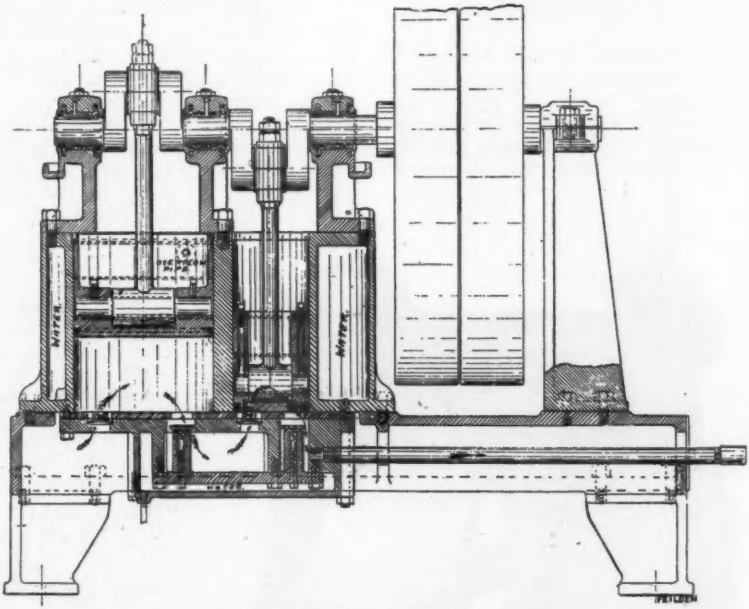


FIG. 11.—SECTIONAL VIEW "PEDRICK AND AYER" COMPRESSOR.

the sectional views. The automatic regulator or unloading device to the "Ingersoll-Sergeant" type of compressor is shown by Fig. 7, and consists of opening a passage by means of pipes between both ends of the air cylinder, which permits the air at full pressure to be admitted on both sides of the piston, thus allowing it to move in equilibrium, and at the same time holds the inlet valves tightly closed. The action, which is entirely automatic, can be readily understood by referring to to an amount sufficient to drive the compressor at a slow speed, the work done being only to overcome friction.

Fig. 8 shows an "Ingersoll-Sergeant" direct steam-driven compressor of the straight-line type, the valves and unloading device being as already described. This arrangement of cylinders and rods gives a direct thrust and pull, and the steam cylinder is fitted with an economical expansion valve gear. It is self-contained, and very compact. Fig. 9

shows a "Ross" belt-driven air-compressing plant suitable for working three caulking tools at a pressure of 60 lbs. per sq. in.

This is fitted with an automatic belt-shifter, not shown in the illustration, but which throws the belt on to the loose pulley when the pressure rises slightly over normal working amount. A compressor having a cylinder 9 in. diameter by 10 in. stroke, and run at 140 revolutions per minute, will deliver 104 cubic feet of free air per minute, requiring 12 h.p. to drive it.

Fig. 10 illustrates a "Pedrick and Ayer" compound belt-driven compressor, whilst Fig. 11 shows a section of same. As will be seen, the cylinders are single acting, and are fitted with trunk pistons. Both the cylinders and valve chambers have the usual water-jacket. The water is first taken into the valve-chamber cooler, then passes up and around the compressing cylinders, and is discharged from near the top. The direction taken by the air is clearly shown by the arrows on the sectional view, the delivery pipe passing under the bed plate. The working parts are all carefully enclosed, to prevent entrance of dirt or dust, and the belt-shifter is provided with an automatic controlling gear, clearly shown in Fig. 10. Its object has already been referred to, whilst its action may be briefly described: the projecting casting on the right of the engraving is a casing containing a diaphragm connected directly to a lever and weight, as shown. The weighted lever is in turn connected by other levers and rods to the valve-spindle of a small air-cylinder, shown on the front of the illustration. The piston of this small cylinder is connected to the belt-shifter. The diaphragm is in connection with the air receiver, and as soon as the pressure therein rises above the normal it lifts the weighted lever, which in turn opens the valve of the small cylinders, which is also connected to the air supply. The result of this is to move the belt-shifter to the fast or loose pulley, according as the pressure in the air receiver is either above or below the normal. By adjusting the weighted lever, changes in the normal working pressure are readily obtained. This automatic regulating device may also be usefully employed when it is required to work several compressors in series, in cases, for instance,

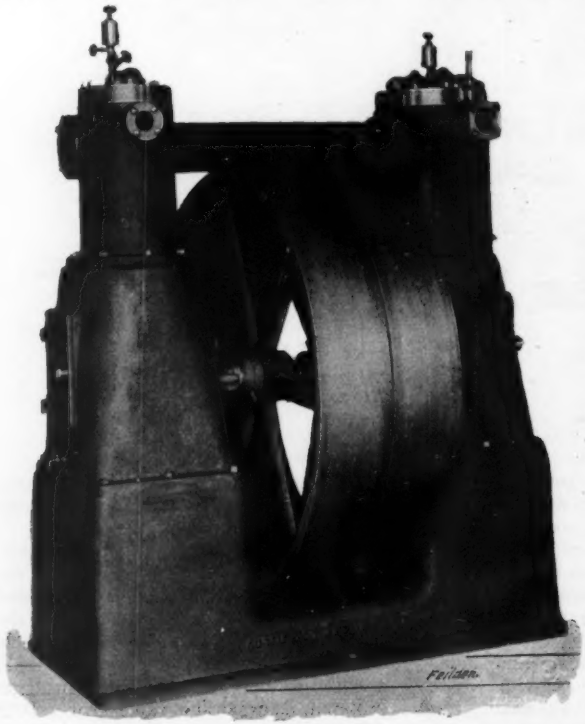


FIG. 12.—"CURTIS" COMPOUND BELT-DRIVEN COMPRESSOR.

where plant has been increased. These valves can be so set that two, three or more compressors will commence to act as the compressed air is drawn from the receivers, and will cease to work when the pressure again reaches the desired maximum. A belt-driven compressor, having cylinders 11 in. by 6 in., and 6 in. by 6 in., will pass 40 cubic feet of free air per minute when driven at 130 revolutions per minute, and requires about 7 to 8 h.p. to drive it. Assuming the air was compressed to 80 lbs. per sq. in.; this would give about 7 to 8 cubic feet of air per minute.

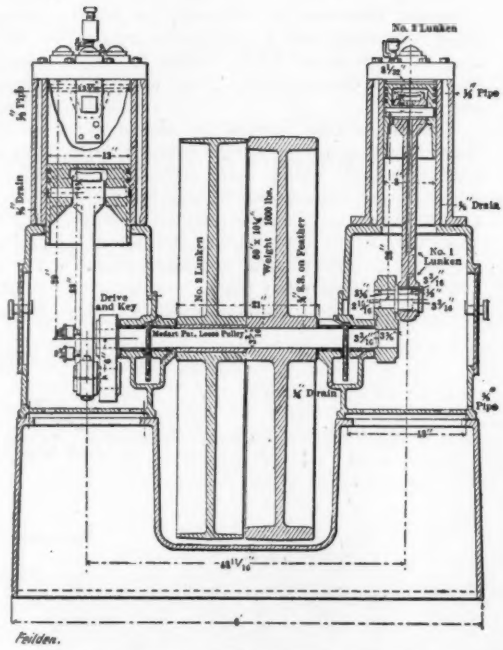


FIG. 13.—SECTIONAL VIEW "CURTIS" COMPRESSOR.

Fig. 13 shows a section of a "Curtis" Compound Belt-driven Air Compressor, whilst Fig. 12 shows an outside view of same. The Curtis type of compressor possesses several interesting features. They are made in a variety of designs, both simple and compound, also belt and steam-driven. The ordinary standard belt-driven "Curtis" type has two single acting cylinders side by side, both of the same diameter, and fitted with water-jackets to cylinders, cylinder heads, and valve cases, to effect a thorough circulation. The valves are of the poppet gravity type, and are made of phosphor bronze; they work without springs and are fitted in separate cases, the discharge valves having renewable seats. The fast and loose pulleys are placed on one side, and the fast pulley is of ample weight to act as a flywheel. The governor is combined with the valve case, and will automatically maintain any desired air pressure, whilst at the same time it does not stop the movement of the machine, and readily responds to any change of pressure in the receiver. Referring now to Figs. 12 and 13, these show a similar compressor, as already described, excepting that the fast and loose pulleys are placed in between instead of at the side of the cylinders, and also, that in this case the cylinders are of different diameter for treating the air twice, having also an inter-cooler, which is shown in Fig. 12, connecting the two cylinders. It does not show in the section, as it comes in the side which is cut away. The inter-cooler consists of a pipe containing a large number of thin brass tubes, and the air passing through the inter-cooler is delivered to the high-pressure cylinder at the temperature of the cooling water. The direction taken by the cooling water is through the low-pressure water-jacket, thence through the inter-cooler, finally passing out through the high-pressure cylinder-jacket. It is claimed for this type of compressor that it is exceedingly economical, and that a compound compressor having cylinders 13 in. by 8 in. by 12-in. stroke when running at 180 revolutions per minute will compress 100 ft. of free air per minute to a pressure of 100 lbs. per square inch, with an expenditure of 15 h.p. In regard

to this point it may be stated that the variation between the efficiency of one good compressor and another is not much, and the difference chiefly relates to the design and construction of the working parts.

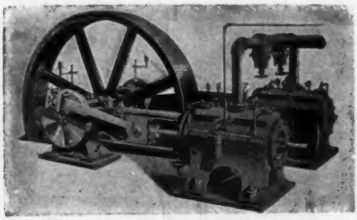
Too much stress cannot be laid upon the necessity of having a good compressor, and one which, besides being economical, will also work continuously without trouble, as, however economical or satisfactory the tools themselves may be, the absence of an efficient and reliable compressed air producer will ruin any plant. To secure good results the combination of sound design with first-class workmanship is indispensable.

It will be readily understood that the powers given as required to drive, or the quantity of air dealt with, are all liable to certain variations, being dependent upon the efficiency of the cooling arrangements; also upon the temperature of the cooling water and the air compressed.

In the next article a sectional and outside view will be given of the valve case and governing arrangement, as used with a "Curtis" compressor, together with illustrations and descriptions of several British-built types.

(To be continued.)

Ewart S. Amos



The Building of a Great Railway.

The Great Central Extension to London.

(Continued from Vol. 1, page 606.)

❀ ❀ ❀

SOUTHERN DIVISION.

THE Southern Division of the Great Central Railway commences at Rugby and extends to Quainton Road, the Northern Junction with the Metropolitan Railway, a distance of 39 miles, exclusive of sidings and lay-byes, which together make up another 23 miles of single line. To ensure rapid progress this division was divided into four sections, namely:—

Rugby to Charwelton 16 miles 24 chains.

Charwelton to Brackley 12 miles 39 chains.

Brackley to Quainton Road 12 miles 61 chains.

The Banbury Branch 8 miles 40 chains.

The engineers for the whole of the Southern Division were Sir Douglas and Mr. Francis Fox, whose firm were the engineers of the Mersey Tunnel Railway, the Liverpool Overhead Electrical Railway, the Southport and Preston Lines, the St. Helens and South Lancashire Railway, the Chester and Connah's Quay Railway, the Wirral Railways, the Scarborough and Whitby Railways, and many others in Lancashire, Yorkshire, and the North. Sir Douglas, who is President of the Institution of Civil Engineers, Member of the Institution of Mechanical Engineers, of the British Association, and corresponding member of the American Society of Civil Engineers, is the eldest son of the late Sir Charles Fox, the constructor of the Exhibition Building of 1851, now the Crystal Palace.

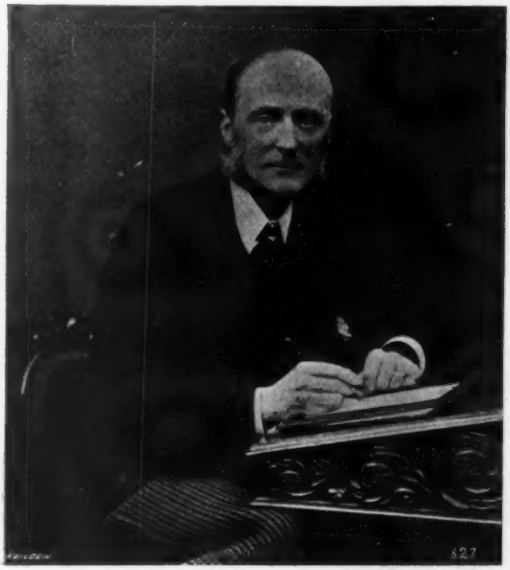
Born in 1840, educated at King's College, London, of which he is a fellow, Sir Douglas entered into partnership with his father in 1861, and has since practised in Westminster as a civil engineer in

SIR DOUGLAS FOX,
President of the Institution of Civil Engineers. Joint Engineer of the Southern Section, G.C.R.

partnership with his brother, Mr. Francis Fox. He is a director of the South Indian Railway Company, and is joint engineer with Sir Charles Metcalfe, Bart., for the Rhodesian and Bechuanaland Railways, of South Africa. He is consulting engineer for the Cape Government Railways.

After the completion of the Mersey Tunnel in 1886, Sir Douglas was knighted by Her Majesty.

He is a Justice of the Peace for the



MR. FRANCIS FOX,
Joint Engineer of the Southern Section, G.C.R.

counties of London and Surrey, and an Alderman of the latter county. He has presided over the G. or Mechanical Section of the British Association, and has contributed numerous professional papers to the Institution of Civil Engineers.

Mr. Francis Fox was born in 1844, and educated at Tonbridge School. Besides being associated with his brother, Sir Douglas, in the above works, he has served on the Joint Commission appointed by the Swiss Government on the Simplon Tunnel. He is a J.P. for Denbighshire and Yorkshire.

Messrs. Sir Douglas and Francis Fox were represented on the various contracts by four resident engineers, assistant engineers, and a large staff of inspectors.

Mr. A. W. H. Casson was the resident engineer for the first section of Contract No. 4, and Mr. Daniel L. Hutchison, M.Sc. (Victoria), A.M.I.C.E., for the second section of the same contract, including the Catesby Tunnel.

Contract No. 5 was under the charge of Mr. F. Douglas Fox, M.A., A.M.I.C.E., and Mr. Lawrence F. White, A.M.I.C.E., was responsible for Contract No. 6. Mr. H. Colvin Smith, A.M.I.C.E., acted as resident Engineer for the Banbury Branch, and as assistant to Mr. F. Douglas Fox on Contract No. 5.

Contrasted with the Northern Division of the line, the steel work involved was of a much lighter character and, with the exceptions of the viaducts over the River Avon and the London and North Western Railway at Rugby, the steel bridges were unimportant. This is accounted for by the fact that the country traversed by the Southern Division of the line is not very thickly populated, and no towns of any magnitude are passed through involving heavy work as, for example, Nottingham and Leicester on the Northern Section. On the other hand, the earth-works may be considered heavy, as although the country is of a gradually undulating nature, the ridges of lias and Oxford clays, and beds of white limestone which ran generally east and west across the line of route, which was almost due north and south, made cuttings and embankments of over 50 ft. in height and depth of frequent necessity, and in one case, a ridge of unusual height at Catesby necessitated a tunnel of over 3,000 yds. in length.

Altogether, the total quantity of earth-

work excavated amounted to 6,200,000 cubic yds., 90 per cent. of this being stiff lias and Oxford clays.

It was pointed out in an earlier instalment of this article, that the Great Central Company resolved, at all costs, to secure a line which would facilitate high speeds, and to carry this out the engineers, particularly of the Southern Division, were face to face with some very severe restrictions, which militated against the crossing of such a country in an economical manner. The maximum gradient allowed on this Division was 1 in 176, or 30 ft. to a mile, and the minimum curve 60 chains radius.

Bridges on the section are numerous, and the question of the relative cost of brick and steel structures formed one of the most important subjects for consideration. It was a moot point as to which would work out at the cheaper rate, as at that time steel-work was very cheap. Taking into account, however, the periodical painting and repairs which are indispensable where steel girders are used, it was determined that brick-work should, wherever possible, be used, and metal work be restricted to such positions as the conditions rendered necessary. The determining factor, however, was headway, and brick structures have, as a rule, been adopted where it was possible to allow 15 ft. 3 in. between the rail level and the soffit of the arch. In cases where the headway was limited, or which reached the minimum of 14 ft. 6 in., steel work was adopted. This decision, together with the nature of the country, rendered it possible, in the construction of the bridges, to conform, with minor deviations which, in themselves, are insignificant, to few types.

THE RESIDENT ENGINEERS OF THE SOUTHERN DIVISION, G.C.R.
MR. L. F. WHITE. MR. D. L. HUTCHISON.
MR. F. DOUGLAS FOX. MR. A. W. H. CASSON.

OVERBRIDGES.

Where the headway varied from 14 ft. 6 in. to 15 ft. 3 in., the plate girder type of 26 ft. 3 in. span was adopted, with brick in cement jack arches. The girders averaged about 2 ft. in depth, the arching being of brindle bricks, generally 9 in. in thickness. The spandrils were filled with concrete in cement, the whole upper surface of which was covered with Cliffe's asphalte. Brick parapets were provided on the outside girders.

The station overbridges, with limited headway, were of the girder and jack arch type, as above, the side spans being 29 ft. 9 in. each. A staircase led from a gap in the parapet over the central pier to the platform, while the interior of the central pier was utilised as a lamp-room. Space is provided between the outside and second girders for gas-mains, etc.

Where a headway of 16 ft. was possible, as is the case for a number of bridges carrying public or occupation roads, a segmental arch of 26 ft. 3 in. span was adopted, with a minimum height between the rails and the springing of the arch of 10 ft., the rise of the arch being 6 ft. 6 in.

In the case of deep cuttings, the span was increased to 55 ft. 6 in., to admit of four lines of way, with a 16 ft. rise of arch.

A type consisting of three semi-elliptical arches of 26 ft. 3 in. span, with a total headway of 15 ft. 3 in., was adopted in cases of limited headway, and where

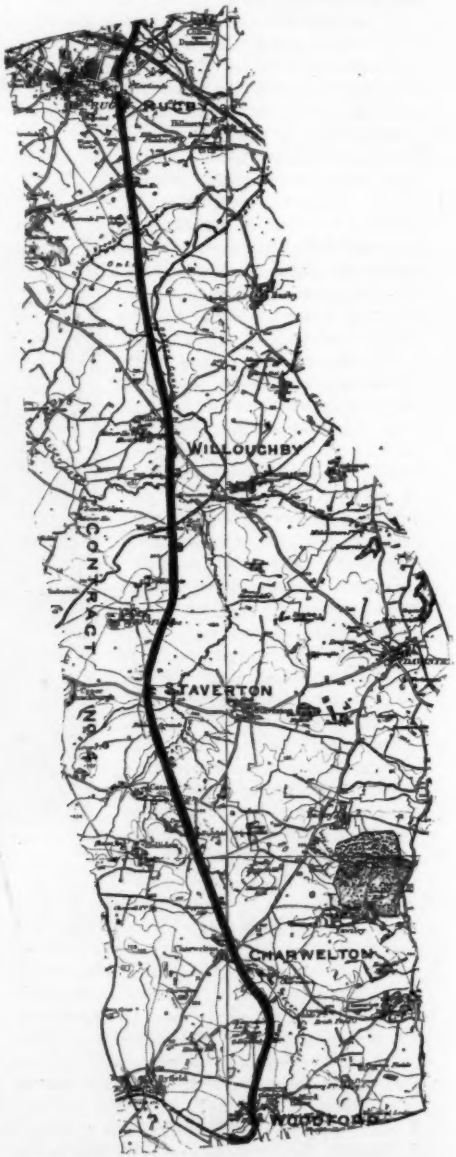
MR. THOS. OLIVER,
Of the firm of Messrs. Thos. Oliver & Sons, Rugby, Contractors of Section 4.

provision was necessary for doubling the lines of way in future.

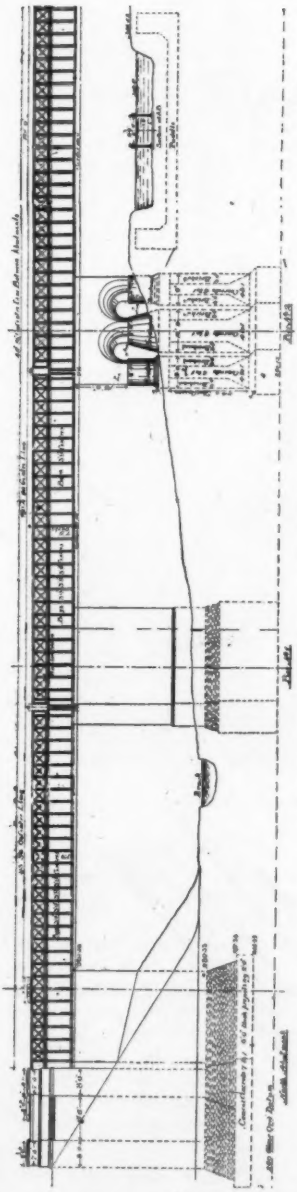
Over wide cuttings where there was insufficient headway for a 55 ft. 6 in. open arch, a type consisting of five segmental arches, each of 26 ft. 3 in. span was adopted. In these bridges, the height from the rails to the springing of the arch is 10 ft., while the rise is 6 ft. 6 in.

Another type adopted for very wide cuttings with flat slopes, contained three segmental arches of 55 ft. 6 in. span, with the centre arch available for four lines of way.

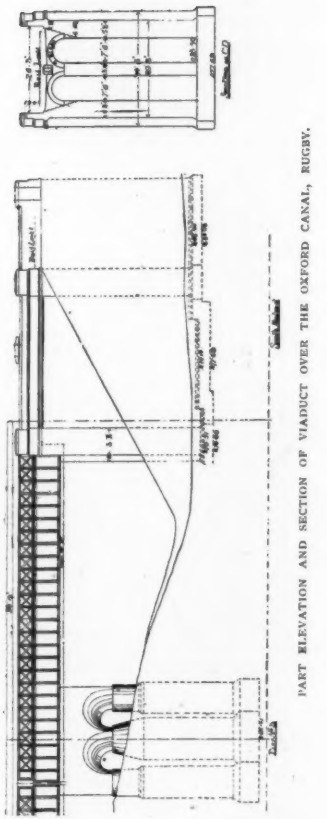
These, with minor modifications, such as the substitution of a semi-elliptical for a segmental form, constitute the more



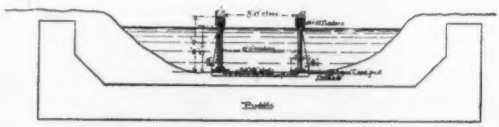
MAP OF CONTRACT NO. 4. RUGBY TO WOODFORD.



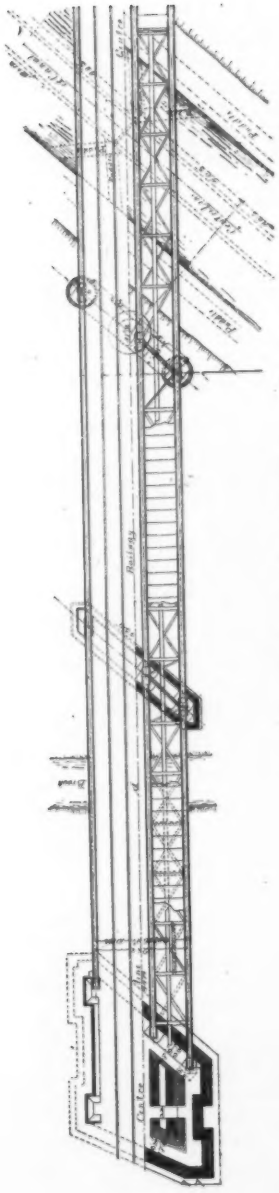
PART ELEVATION OF VIADUCT OVER THE OXFORD CANAL, RUGBY.



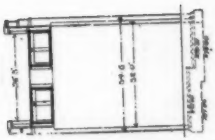
PART ELEVATION AND SECTION OF VIADUCT OVER THE OXFORD CANAL, RUGBY.



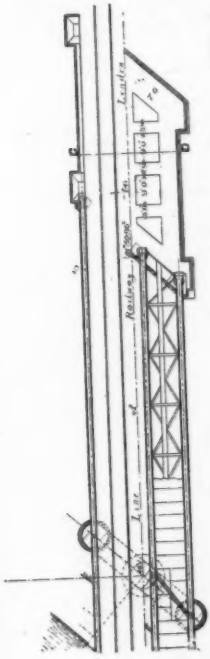
CROSS SECTION OF PUDDLE AND TEMPORARY TROUGH: VIADUCT OVER THE OXFORD CANAL RUGBY.



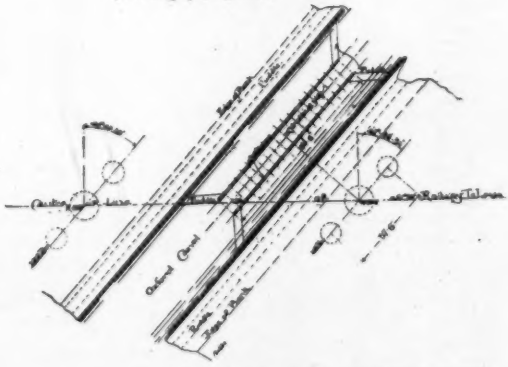
PART PLAN OF VIADUCT OVER THE OXFORD CANAL, RUGBY



Cross Section



PART PLAN AND CROSS SECTION OF VIADUCT OVER THE OXFORD CANAL, RUGBY.



PLAN OF PUDDLE AND TEMPORARY TROUGH: VIADUCT OVER THE OXFORD CANAL, RUGBY.

important structural forms of the over-bridges.

UNDER BRIDGES.

In the case where headroom is not limited an arrangement is adopted whereby the girders are placed directly, or nearly so, under the rails. $\frac{3}{8}$-in. steel plates are used for the flooring, with an intervening layer of asphalte between them and the ballast. Steel-plate parapet girders, 26 ft. 3 in. apart, support, on either side, a footway for the platelayers.

The particular feature of this type of bridge is that each pair of rails is provided with a complete span and structure to themselves, consisting each of an outside and inside girder. The cross girders are 7 ft. apart from centre to centre. A raised platform for platelayers is provided on each side supported by flat plates resting on independent outside parapet girders of steel plate.

A type adopted for occupation roads where the headway is limited, with a span of 12 feet, consists of parapet girders 5 ft. 3 in. deep, and Hobson's steel flooring, 12 in. deep, riveted on to T's at 2 ft. 6 in. centres. The total weight is $8\frac{1}{2}$ tons, consisting of the flooring 6 tons, the joists 1 ton, and the parapet $1\frac{1}{2}$ tons. Usually there are splayed wing-walls, tapering from 4 ft. $1\frac{1}{2}$ in. at the base against the abutment to 2 ft. $7\frac{1}{2}$ in. at the newels, with ashlar strings and caps to the pilasters and newels. The abutments are 4 ft. 3 in. at the base, and are stepped at the back to 3 ft.

The brickwork of all bridges was faced with Staffordshire Brindles, in black mortar with an ordinary drawn weather joint. The abutments, walls, &c., directly in contact with earthwork, were backed up with 16 in. of broken stone dry lining; clay-puddle backing, and weep-pipes leading the drainage to the front of the walls. As far as possible, standard spans for arches were adopted throughout, viz. :

OXFORD CANAL VIADUCT, LOOKING SOUTH-EAST.

		ft.	in.
Over-Viaducts	Segmental Span	34	3
Large Overbridges	,, ,,	55	6
Small Overbridges	Semicircular Span	26	3
Do.	Segmental Span	26	3
Do.	Elliptical Span	26	3
Tunnel under Bridges	Segmental Span	12	0

Continuing southwards from the point at which the Northern Division ends, viz. (51 miles 69 chains from Annesley), Contract No. 4, or the Rugby section begins, extending to Woodford, a distance of 15 miles 69 chains, with an additional 35 chains of branch line, connecting the East and West Junction Railway with the Great Central.

The contractors for this section were Messrs. Thomas Oliver and Son of Rugby, the sub-contractors being Messrs. Butler & Co., of Leeds, who executed the steel work, and Messrs. John Parnell & Son, of Rugby, who erected the station buildings.

The work commences at the Oxford Canal Viaduct, carrying the railway over the Oxford Canal, which is itself on an embankment, and a portion of the Clifton Brook.

The viaduct consists of four spans of steel plate girders, viz., two of 91 ft. each, one of 90 ft., and one of 120 ft. Each span is made up of four girders running parallel to one another, each line of way thus forming a distinct bridge.

The two inner girders are of the "fish-bellied" type, being 3 ft. 9 in. deep at each end, reaching a maximum of 7 ft. and 8 ft. 6 in. at the centre. They are 6 ft. apart and carry the two rails at a distance corresponding to the 6 ft. way above. The outer girders are 10 ft. 11 in. distant from the inner ones, and are 7 ft. 9 in. deep surmounted by a lattice work parapet 4 ft. 8 in. above the rail level. There are rail girders 1 ft. 9 in. in depth between the cross girders, carrying the timbers of the outer rails. The cross girders themselves are 3 ft. 4½ in. deep, and are placed 15 ft. apart.

A steel decking ⅜ in. thick fixed on the edges of the top flanges of the girders runs from end to end.

The southern abutment foundations are carried down to a depth of 6 ft. in good solid blue clay.

The next two piers, viz., those supporting the span which traverses the canal itself were sunk through the canal bank and rest on cylinders.

The next pier is of brickwork in cement and is 6 ft. thick, carried up parallel in thickness. Both this and the northern abutment were carried well down in the dry boulder clay.

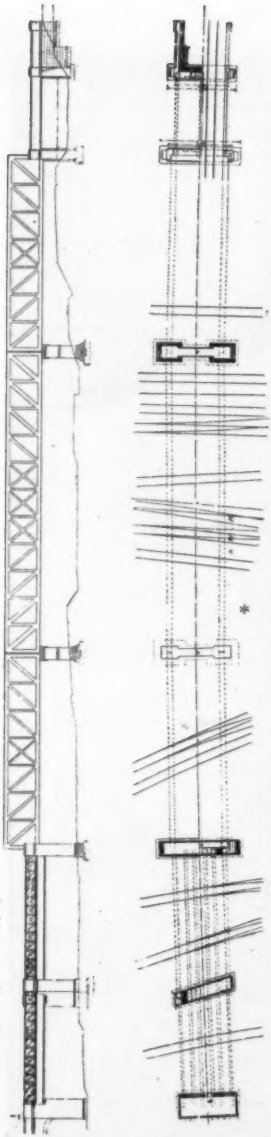
The work in connection with the sinking of the piers was of an interesting character, the company being under an agreement with the canal company, whereby a penalty of £20 per hour would have been incurred in the event of any obstruction to the traffic being caused, and a further £1 per 1,000 gals. of water wasted. To guard against an escape of water from the canal, in the event of any settlement occurring during the sinking of the cylinders through the embankment, the engineers designed a special trough of steel, sufficiently large for the boats to pass through, to be used temporarily during the construction of these piers. Owing to the centre line of the railway being much on the skew with the canal, the temporary trough had to be raised from its original position opposite the south pier which was first built and placed in position opposite the pier on the north bank.

The trough was 80 ft. 6 in. in extreme length, 8 ft. wide inside, and 5 ft. deep to the top of steelwork; a timber sill 12 in. square running from end to end to serve as a fender for barges going through was bolted to the top flange.

The side plates were $\frac{5}{16}$ in. thick and stiffened every 4 ft. with 5 in. by 2½ in. by ⅜ in. T's, while the bottom plates were ¼ in. stiffened with joists 6 in. by 4 in. by ½ in. under the floor. The trough was constructed on the canal bank and was caused to float into its required position by means of timbering up the ends and caulking. By removing the timber ends, it was sunk on to the bed of the canal which had been prepared to receive it beforehand. After the trough had been sunk into position, a water-tight puddle dam was constructed from each of the corners to the canal side. In the event, therefore, of any disturbance of the canal lining taking place during the operation of sinking the cylinders, only that portion contained between the dams would have been affected and the only leakage that could take place would be between the canal side and the nearest side of the trough.

After the completion of the sinking of the first three sets of cylinders, the trough was raised by reinserting the timber ends in the grooves provided, and pumping out the water. The puddle was dug out from along the bottom by divers before the attempt to lift was made. The same process was gone through in connection with the sinking of the second set of

PART VIEW OF THE STEEL PORTION OF VIADUCT OVER THE L. & N. W. R., RUGBY, SHOWING SIGNAL GANTRY ERECTED BY THE G. C. R. COY.



ELEVATION AND PLAN OF STEEL PORTION OF THE VIADUCT OVER THE L. AND N. W. R., RUGBY.

* Spare ground belonging to the L. and N. W. R. Co., on which the Steelwork for the Viaduct was deposited and picked up by Steam Travelling Crane from the Temporary Staging.

cylinders. After they had all been sunk and the girders erected, the trough was removed from the canal by means of a steam crane from the top, and was taken to pieces at the canal side.

The difficult task was accomplished without a hitch of any kind, the lining of the canal being unaffected and no leakage consequently taking place.

In sinking the cylinders, the correct position was first carefully ascertained and marked out. A flat benching was then cut out on the canal slope on which was placed the cutting edge of the lower ring of the cylinder. Two men excavated inside and filled into skips which were drawn up by a steam crane and tipped on to a staging. As the cylinders sank, the brick lining was filled in to assist in sinking. When the full depth was reached, the bottom was undercut one foot round the circumference of the cylinders to increase the bearing area. The inside was then filled in with concrete. The larger cylinders are 12 ft. 9 in. in diameter, 24 ft. long, and weigh 17 tons. The smaller ones are 9 ft. in diameter, 24 ft. long, and weigh about 14 tons. In the case of the larger cylinders, the lining was 3 ft. 4½ in. thick, and the smaller 2 ft. 3 in. The maximum load on the clay is 2¼ tons per square foot.

Some difficulties cropped up in the case of two of the cylinders on account of a layer of wet gravel being struck, which necessitated continuous pumping until the cutting edge had reached the underlying bed of clay, when the water ceased to come in.

The total weight of steel work in the viaduct is 675 tons, and 96 tons are represented in caissons.

Leaving the viaduct, a heavy bank of considerable length, follows, containing 296,427 yards of material, the whole of which had to be brought from the Rugby cutting across the Rugby Viaduct after that structure had been completed.

The Clifton Brook is carried through this bank at its deepest point by a 12 ft. culvert, which had to be carefully dealt with when tipping the bank.

The Rugby Viaduct immediately follows. It spans the main lines, the Peterborough branch, and the sidings of the London and North Western Railway, and consists of a series of 14 brick arches, one of 14 ft.

RUGBY VIADUCT (LOOKING SOUTH) SHOWING CONTRACTOR'S LINE OVER WHICH ALL THE EARTHWORK WAS CONVEYED TO FORM THE BIG BANK BETWEEN IT AND THE OXFORD CANAL VIADUCT.

span and thirteen of 26 ft. span each, followed by a steel bridge made up of two steel plate girders of 58 ft. and 75 ft. span respectively; two steel lattice girders of 105 ft. span, and one steel lattice girder of 165 ft. clear span.

The viaduct has a total length of 748 ft., and is carried at 45 ft. above the surface.

The arch piers are 4 ft. thick at springing, while the rise of arch is 8 ft. 6 in. The foundations are in blue clay, and vary in depth from 5 to 20 ft. from the surface. The lattice girders over the North Western main lines and sidings had to be erected on a staging a considerable height above their finished level, and when built, lowered on to their beds. This was done without any dislocation of the traffic.

The ends of the lattice girders are supported on fixed and rocker bearings (Westwood and Rigby's Patent), the southernmost end of each span being fixed leaving the opposite end to rock to and fro with the expansion and contraction of the metal. The bearings are carried on granite blocks, and bolted through them into the concrete foundation. The piers are of brickwork in cement, faced with brindles.

After leaving Rugby Viaduct, the line crosses a new street diversion by a 40 ft. span plate girder bridge. This large diversion has been made to connect South Street with Abbey Street, forming a connection between the Clifton Road and this newly built portion of the town.

About 13 chains south of the Rugby Viaduct the large Rugby cutting is entered, which is $1\frac{3}{4}$ miles long, and 1,329,000 cubic yds. of material were excavated therefrom.

Five public roads are carried across this cutting at various points, and also one occupation bridge of 5 arches.

The first mile of this cutting is entirely through beds of glacial origin—gravel above and sandy clay below.*

* For full description of the geology, see:—"Excursion to the New Railway at Catesby, Northamptonshire," by Beeby Thompson, F.C.S., F.G.S. Proceedings of Geologists' Association. Vol. XIV., Part X. November, 1896; "Geology of the Great Central Railway, Rugby to Catesby," by Beeby Thompson, F.C.S., F.G.S. Quarterly Journal of the Geologists' Society. February, 1899. Vol. LV.

The gravel is what is known as Mid-glacial Gravel, it is mostly rather coarse and dirty, but towards the south is cleaner, and in some places approaches to a sand. The thickness is very variable, chiefly owing to its irregular junction with the boulder clay below, but may reach to 25 ft. This gravel seems to have its limits towards the south, determined by a ridge of clay it could not surmount, for it finishes just beyond the 54th mile at a height of about 398 feet above O.D., so that the southerly Lower Lias slope of the cutting is quite free from it, and so, apparently, is the country for some few miles around.

The Sandy Clay forming the lower part of the cutting on this mile is a grey and brown contorted Boulder Clay; it is most varied in composition ranging through tolerably pure clay, through loam, to nearly pure sand, and, on the whole, peculiarly free from all erratics, or large fragments of any kind, though here and there patches of pebbles occur, as though dropped by stranded ice-blocks. This clay to the south rests against the northern face of a Lower Lias clay slope, indicating that the Hillmorton ridge stopped its southerly extension as it did the gravel. The depth of this Boulder Clay, representing what is known in other parts as the Lower Boulder Clay, is likely to be as great as the contemporaneous sand-beds of Hillmorton, 170 feet.

Where the base of the Contorted Boulder Clay can be seen, as it could be on the Lower Lias Slope referred to, near to 53½ miles, between it and the undisturbed Lower Lias, was a few feet of Blue Boulder Clay composed chiefly of local material, Lias limestones in this were deeply scratched. An intermediate layer of this kind has been observed at another point on the line, near to Woodford.

From about 53½ miles to 54 miles 10 chains the exposure of Lower Lias increased at the expense of the Drift beds, but as the beds of Lias dip towards the south more rapidly than the line falls in that direction a succession of live zones was exposed. The zone of *Ammonitis Turneri* and *A. semicostatus* at the bottom of the excavation at and about 53 miles 40 chains, the zone of *Ammonitis obtusus* next above and extending further southwards and so on. At and near the three-arch bridge carrying the Hillmorton and Dunchurch Road, the cutting was about 45 ft. deep and exposed in upward succession the Optus zone (part), Oxynotus and Raricostatus zones (25 ft.), Armatus zone (part).

(To be continued.)

MACHINERY, APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

NEW VERTICAL HIGH-SPEED GAS ENGINE.

IT has been stated by a responsible authority that it would probably pay established gas works to generate electricity by gas engines and dynamos attached to the works for the supply of electrical current for illumination and motive power. The suggestion seems rather startling, considering the long-continued fight that has existed between the gas and electrical industries, but there is nothing in the proposition in itself to disentitle it to serious consideration. The gas companies have for long recognised the inevitableness of electrical light competition, and the only criticism of any weight they now attach to the rival light is its greater cost. So, considering that the demand for electric light may be considered a permanent factor, independent of any improvement in gas-lighting at present conceivable, there is every reason why gas companies should supply with the electric light such of their customers as may prefer it, providing they can do so at a profit.

Whether or not such a profit is, under the circumstances, possible, depends entirely on the efficiency of the gas engine employed to generate the current. The capacity of the gas engine, as it now stands, to compete with steam power on this basis has been the subject of an amount of controversy in itself sufficient to show that the gas engine is now regarded a factor to be reckoned with in the future as a prime motive power.

We are enabled in the present issue to give some particulars of a new high-speed gas engine, on behalf of which some important claims are made, which we had the pleasure of inspecting at the works of Messrs. Thomas Melvin and Sons, Engineers, Glasgow. It is of the vertical type, and, as will be seen from the photographic plate attached, very compact and workmanlike in appearance. The following are some of the important improvements as compared with the ordinary gas engine :—

1. A reduction in size and weight.
2. Simplicity of construction.
3. Economy of fuel.
4. Accessibility of working parts.
5. Reduction in cost of manufacture.
6. Direct driving and steady running.

With regard to the size and weight of the engine, the manufacturers give the aftermentioned particulars :—

The dimensions of the engine under consideration, which runs at 30 brake-horse-power as compared with those of any other known gas engine of the same efficiency, are :—

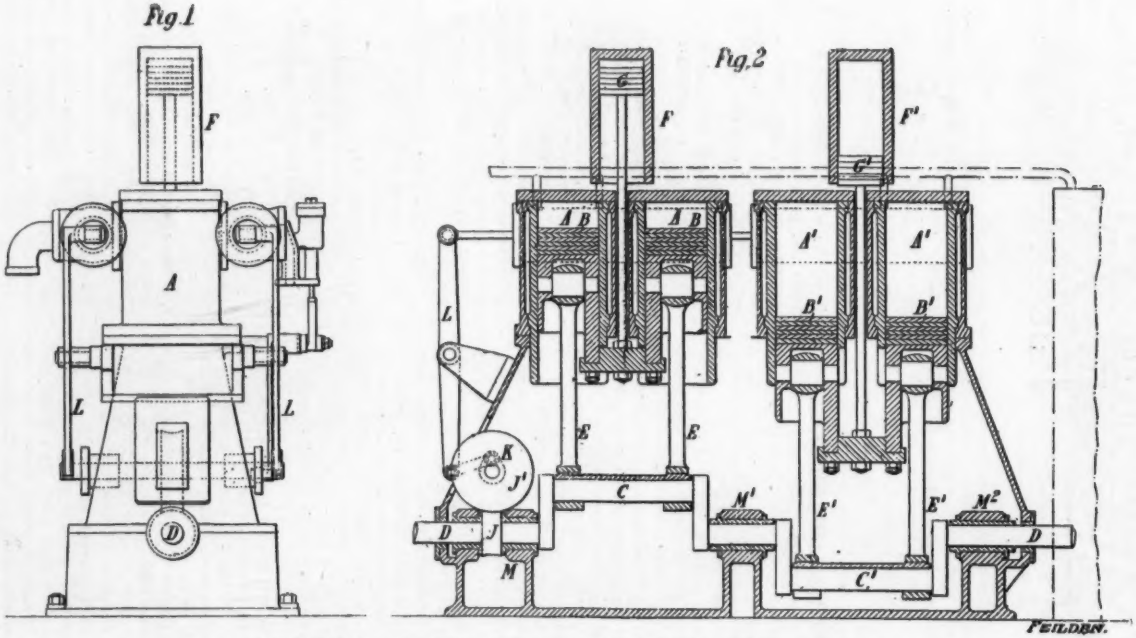
VERTICAL ENGINE UNDER NOTICE.

Length, 4 ft.
Breadth, 2 ft.
Depth, 3 ft.
Diameter of fly-wheel, 2 ft. 6 in.
Weight, 1 ton 10 cwt.

ORDINARY HORIZONTAL GAS ENGINE.

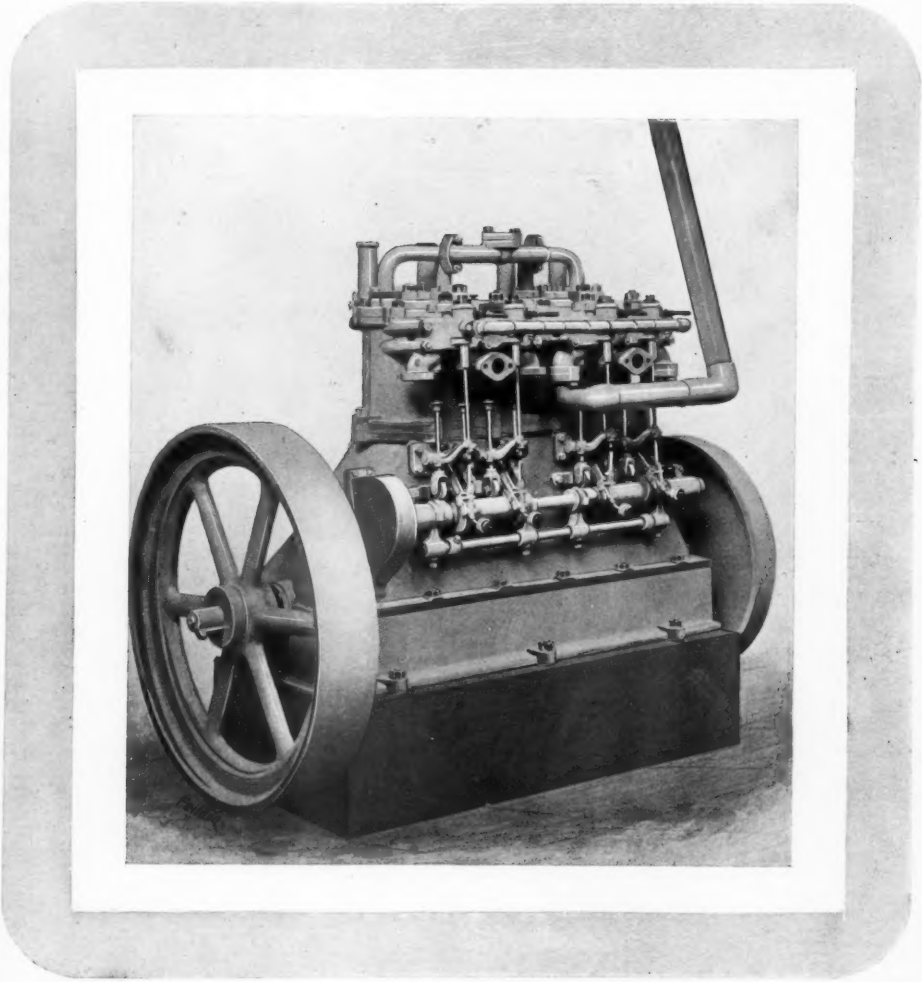
Length, 11 ft. 3 in.
Breadth, 7 ft. 9 in.
Diameter of fly-wheel, 5 ft. 10 in.
Weight, 7 tons 10 cwt.

The claims made by the inventors on behalf of their patent are very numerous, and we cannot do more than broadly specify them on this occasion. One of the chief relates to the utilisation of the exhaust gases, which they make use of in three several ways, thereby, as claimed, effecting a new economy in the gas engine. The means of utilising the exhaust gases as specified are as follows :—1st, By condensing the gases in the exhaust pipe, or in a chamber, or pipes arranged for the purpose, the partial vacuum caused by the



END ELEVATION AND LONGITUDINAL SECTION OF THE NEW VERTICAL HIGH-SPEED GAS ENGINE.

SUP



NEW VERTICAL HIGH SPEED GAS ENGINE.

condensation assisting the instroke of the piston. 2ndly, By employing an auxiliary piston, and allowing the exhaust gases to pass from the main cylinder into the auxiliary one in order to actuate the auxiliary piston; and 3rdly, By utilising the gases to heat water or to raise steam, or to blow a furnace or fires to raise steam. For this purpose, they employ a containing vessel provided with tubes closed at one extremity, the gases being projected into the open ends under pressure from the cylinder by means of a port or valve at any point of the firing stroke. The operation of raising steam from the burnt gases is stated by the inventors to be carried out in the following way:—The water, which is first slightly heated in the cylinder water jacket, is run by gravitation or otherwise to the exhaust pipe or chamber leading to the atmosphere, where its temperature can be raised still higher; from this it is carried into the vessel containing the burnt gases, a non-return valve preventing the gases returning to the cylinder when the exhaust valve is opened. Another means for effecting the same object forms also part of the invention.

We give two sectional views of the engine—an end elevation and longtitudinal section—by which its general construction can be estimated. The plate attached gives an exterior view of an engine with certain modifications of the plan shown, but which do not, however, affect the principle of the engine.

As will be seen, the engine is constructed so that as the piston reciprocates perpendicularly, the cranks being below the cylinder and working in a closed chamber, the weight of the piston or pistons and rods rests on the cranks when the engine is in motion. When the engine runs at a high speed the weight tends to lift the crank on the upstroke of the piston, but as the engine is a four-stroke one, having a downstroke intake, an up compression stroke, a down firing stroke, and an up exhaust stroke, it follows that, at the up compression stroke, the compression can be adjusted to prevent all the weight from raising up the crank, although at the up exhaust stroke the upward momentum of the piston and rod lifts the weight off the crank and causes the connections to knock. In order to prevent this an air-cushioning cylinder is employed either above, below, or alongside the motor cylinder, drawing in air at each downstroke and compressing it at each upstroke. As, however, the compression is only required at the up exhaust stroke of the motor piston, a valve opening into the cushioning cylinder is provided, which is capable of being operated by means of a lever and cam or eccentric, on a shaft going half the speed of the crank shaft, in such manner that the valve is opened on the compression and firing strokes of the motor piston but is closed on the exhaust stroke. The valve can be actuated by a diaphragm or a small piston fitted in or to the motor cylinder so as to be opened by the pressure and closed by the action of a spring or weight when there is no pressure in the cylinder.

In order to give the crank an impulse at every revolution two motor cylinders are cast as close together as possible and each provided with an air-cylinder either above or below, or a single air cylinder can be used between them. The piston rods of these twin cylinders are connected to one crank and one cylinder is fired at each revolution.

To give the crank two impulses to each revolution, two cranks are made on the same shaft opposite each other, and two motor and two air cylinders connected to each crank. The closed chamber in which the cranks are is partially filled with a lubricant in the ordinary manner.

For the starting of the engine, compressed air or compressed gas is employed. In large single gas engines, mixture under pressure is employed, the air and gas being pumped into a reservoir by a small auxiliary gas engine. By the employment of cams, the air and exhaust valves are lifted at every revolution until the engine is started. It is claimed that by these means it is not necessary to give the piston such a strong shock as in starters which act only once at a time, or at every second revolution.

With reference to the elevation and section shown by Figs. 1 and 2, A, A show two motor cylinders of one set, and A^1, A^1 two motor cylinders of the other set, the pistons B, B of the set A being connected to the same crank C of the motor shaft D, and the pistons B^1, B^1 of the set A^1 being connected to the same crank C^1 (which is opposite to the crank C) of such motor shaft. In the illustrations the pistons B, B and B^1, B^1 are shown as being connected to the cushioning piston, the same being connected to their respective cranks by separate connecting rods E, E and E^1, E^1.

The set of motor cylinders at A is provided with an air cushioning cylinder F and the set A^1 with an air cushioning cylinder F^1, these air cushioning cylinders being provided with pistons G and G^1 respectively. The motor pistons B, B and B^1, B^1 are connected to the cushioning pistons G, G^1, as shown in the drawings.

The valves for controlling the supply and exhaust and ignition of the charges to and

from each set of motor cylinders A and A^1 may be of any suitable construction, a suitable construction of valve for this purpose consisting in piston valves on the opposite sides of the motor cylinders, and a piston valve arranged on one side of such cylinders, the whole being driven from the motor shaft D by any suitable arrangement such as the skew wheels J, J^1, crank K and pivoted lever L, so that the valves are moved in the proper directions, but any other suitable arrangement for actuating the valves may be employed.

Apart from the mechanical features we have described, it is stated on behalf of this engine that all parts are easily accessible and can be taken down and fitted up in a very short time, and that, owing to the reduction in its comparative size and weight, the engine can be made at a cost considerably lower than that of any other type of engine of similar power in the market. It is pointed out that a growing demand exists for a good high-speed gas engine for electric lighting installations, the drawback to their use for this purpose having hitherto been the necessity of employing belting to convey the power to the dynamo. This engine is so constructed as not to affect the voltage, and it runs at high speeds without jarring or jolting, having, in trials conducted by Professor W. H. Watkinson, attained up to 500 revolutions per minute under full load.

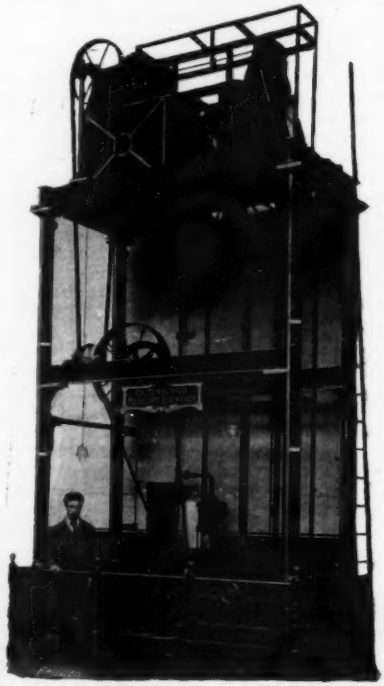
We are informed that the British Patents Company, 141, West George Street, Glasgow, have been entrusted with the formation of a syndicate to acquire the rights to this invention.

READERS of "FEILDEN'S MAGAZINE" are reminded that the Editor will be pleased to hear from them with advance particulars of any new machinery or specialities they may be bringing out or interested in. Nothing mediocre, stale, or commonplace will, however, find room in these columns.

Her Britannic Majesty's Consul at Granada, Nicaragua, in writing to the Editor of "FEILDEN'S MAGAZINE" under date 15th ult., says:—"I have carefully read the copy (of the Magazine) you were good enough to forward, and feel confident that British Trade will gain materially by your Magazine, of which the reading and illustrations are most interesting and instructive."

A MERCURY FOUNTAIN.

We give an illustration of the "Mercury Fountain" for which Mr. Charles Bright, F.R.S.E., was awarded the only Gold Medal at the recent Earl's Court Exhibition. It was constructed under his design and direction for the Queensland Government, who were desirous of illustrating in some striking way one of the natural products of their territory. The general construction of the fountain will be easily



MR. CHARLES BRIGHT'S MERCURY FOUNTAIN.

understood by the view, which is from a photograph. Some two and a-half tons of mercury were employed, representing a value of some £600. The mercury was arranged to run by gravity over the edge of the fountain in a thin sheet, and was conducted from the tank into which it subsequently flowed to another tank overhead by an elevator cup-pump. The pump was worked very satisfactorily by a 2 h.p. Langdon-Davies alternating motor.

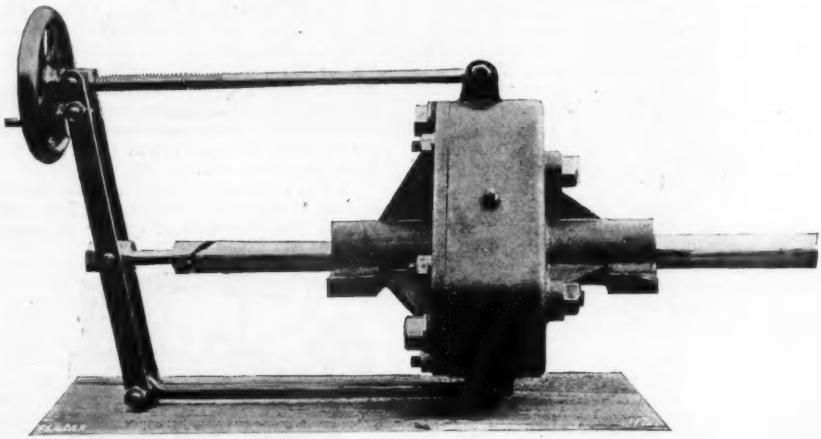
NEW VARIABLE SPEED GEAR.

THE difficulties associated with variable gears in automobile vehicles are well known, and many attempts have been made, and still are being made, to devise some form of speed controller which will not involve the drawbacks which have appeared almost inseparable from the principle of similar mechanisms.

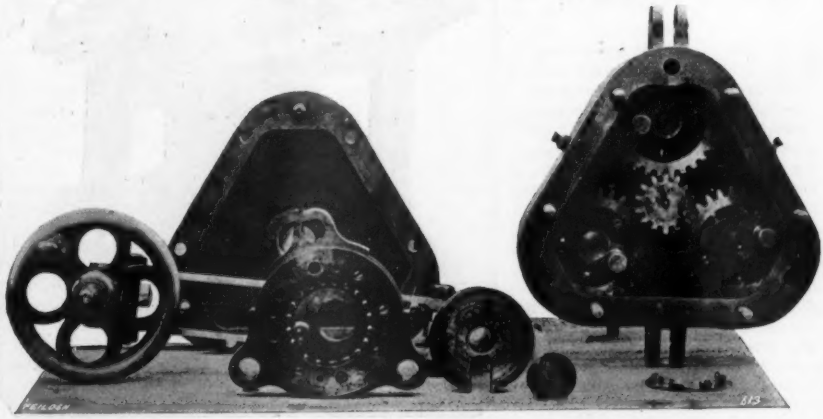
A form of variable speed gear has been brought before our notice, which presents some new features, worthy, as we think, of attention. The mechanism was exhibited at the Richmond Motor Car Show in June last, but since then has been considerably modified, and, as stated, improved.

The arrangement in question, which has been invented by Mr. W. H. Newman, can be understood by a reference to the accompanying illustrations.

On the end of the constant speed shaft is an eccentric of variable throw, which is connected to three roller clutches contained in three gear wheels, working on fixed



EXTERIOR VIEW OF THE VARIABLE SPEED GEAR.



INTERIOR ARRANGEMENT AND PARTS OF THE VARIABLE SPEED GEAR.

studs. The three gear wheels drive one pinion on the end of the variable speed shaft. The three roller clutches drive the gears in one direction only, and are connected to eyes on the eccentric strap. As the eccentric revolves, it oscillates the clutches through an angle depending on the throw of the eccentric, and which can be varied from zero to a maximum. With zero throw, the variable speed shaft is at rest, but begins to move as soon as the eccentric is given a slight throw, and attains a maximum speed with the maximum throw of the eccentric.

The eccentric is compound, *i.e.*, it consists of a small eccentric within a larger one, and by revolving one of these relatively to the other, the combined throw can be altered. They are revolved relatively to each other by means of a pin, engaging with straight and spiral slots formed in the end of the constant speed shaft, and in the end of another shaft within it, the position of the pin, and therefore the throw of the eccentric, being controlled by the hand wheel.

In the apparatus illustrated, with the constant speed shaft running at 650 revolutions per minute, the variable speed shaft can be altered in speed from zero to about 500 revolutions per minute.

The appliance has been on view in working order at an engineering works in London.

"IDEAL" SAW GUARDS AND BENCHES, ALSO PATENT FIREWOOD MACHINERY.

OWING to recent legislation, circular saws are not now allowed to be used without guards. It is therefore important to users to adopt guards such as give the greatest protection with the least obstruction to the work. But as saws vary in diameter, it is equally important that the guards should be thoroughly adjustable in every respect in order that the fullest protection should be afforded with the maximum of convenience, whatever be the diameter of saw in use. We have recently had placed before our notice more particulars of the saw guards designed and manufactured by the well-known saw-mill engineers Messrs. M. Glover & Co., of Leeds, and think these justify us in devoting some of our space to their consideration.

The attachment which Messrs. Glover & Co. have produced consists of an adjustable hood which when at work completely covers the upper half of the saw and which, by very simple yet ingenious mechanism, can be fixed, removed or altered in circumference easily and expeditiously. The hood consists of two portions: the "rear-guard" protects the rear portion of the saw, whilst brought over and fixed to it is an adjustable "front guard," whose position is regulated by a simple supporting and adjustable bracket on an upright spindle at the side. The whole device, as we have said, is as simple and effective as any device can be, and in practice has shown itself efficient in every respect without presenting the least encumbrance to the work. Its general appearance is shown in the following illustrations reproduced from photographs of one or two of Messrs. Glover & Co.'s saw-benches.

In Fig. 1 is shown some small saw-guards as used in the British Government Telegraph Works Department, and chiefly by metal-

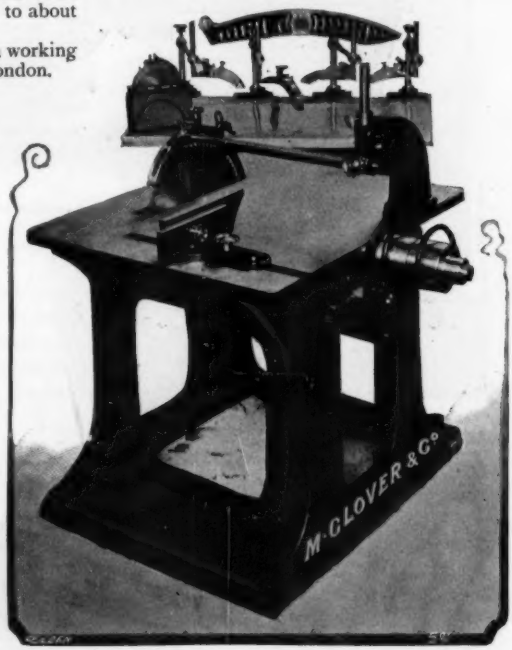


FIG. 1.—SAW-BENCH ADAPTED FOR SAWS UNDER 8-IN. DIAMETER.

FIG. 2.—SAW-BENCH ADAPTED FOR SAWS UP TO 3 FT. 6 IN. DIAMETER.

workers and firms using saws under 8-in. diameter. The small bench illustrated is equipped with a guard of a miniature size, compared with others made, rising to 6 ft. diameter, but finished in polished steel and brass in exactly the same way. Some specimens of hoods are seen at the back showing different sizes.

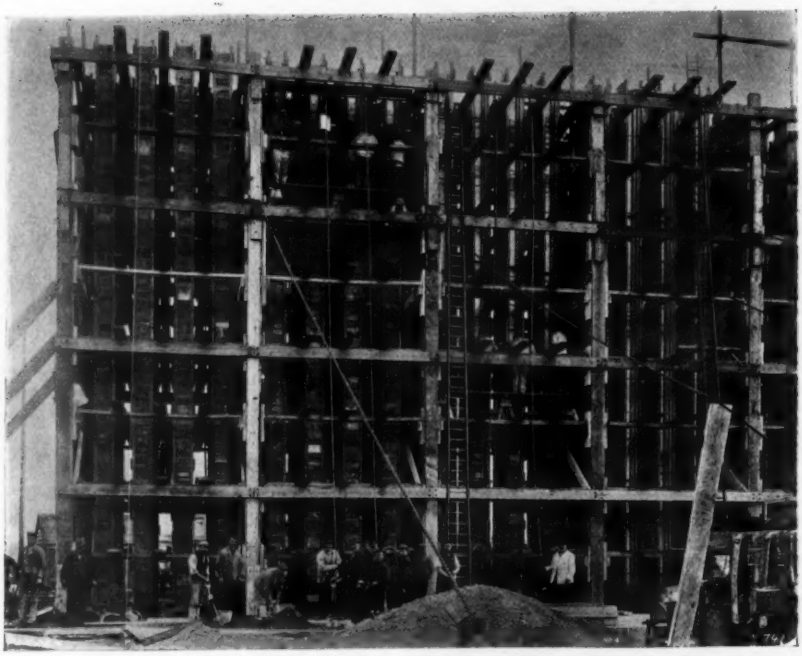
A larger saw-bench is shown in Fig. 2, the saw being 3 ft. 6 in. in diameter. These benches are exceedingly massive, being cast in one piece with special wide bearings and steel spindles, and provided with means for "setting up" any wearing of the brasses, so that the rumbling and vibration of the ordinary benches is done away with. Attention has been paid to some details ordinarily overlooked, among which we may mention the instance of the loose pulley being of smaller diameter, with a taper flange leading to the fast pulley, thus ensuring a tight belt when working, and a slack belt when on the loose pulley. The life of the belt is in consequence prolonged, and the hole or bush of the pulley preserved. The arrangement of the belt-shifting mechanism, which is both handy for the sawyer and perfectly safe since it is self-locking whether the belt is on the fast or the loose pulley. This particular form of "fence" is used for sawing thin boards, but various styles are made for different purposes. Messrs. M. Glover & Co. also make improved machines for sharpening saws, and special machines for "splitting," "arranging," and "bundling" firewood, and which effect such a radical saving in wages as to practically insure large profits to users.

THE HENNEBIQUE SYSTEM FOR DOCK FOUNDATIONS.

THE London and South Western Railway Company's Docks at Southampton are being further elaborated, and we are able in this connection to give some account of the Hennebique Ferro-Concrete System used for the piles for the new foundations. The Hennebique system has been in use for some time in France for the construction of railway bridges, large factories and other important works, the French owners of the patent having a contract to the value of some £350,000 in connection with the Paris Exhibition. It has only been recently introduced into this country, and the following particulars therefore may be interesting.

The Hennebique pile system consists of a combination of rich Portland cement and steel rods in such proportions as to form practically a new constructional material. In making one of the piles, a timber mould of an inside section corresponding to the size of pile required, is erected and securely fixed in a suitable scaffolding. One vertical face of this mould is kept open.

After the mould is erected and everything proved perfectly plumb, the shoe or pile is placed in the bottom of the mould. This shoe has the top ends bent inwardly to properly grip the concrete. The vertical steel rods are then placed in position, and distance pieces dropped over these rods from the top. The Portland cement concrete is then passed to the workman, who tips it into the mould in quantities just sufficient to enable him to properly ram the concrete round and between the rods and distance pieces. As he gets higher with this concrete, the face of the mould, previously mentioned as having been left open, is gradually closed by suitable shutters, which are fixed by the workman as he proceeds, and the process of ramming is continued until the mould is quite filled. After about three days, the moulds are stripped from round the concrete, which though not absolutely set, is sufficiently so to retain the form given to it. After being moulded, a period of from 28 to 40 days is allowed for the pile to dry. When dry, it can be driven in a similar fashion to a timber pile, with the exception that extra protection



GENERAL VIEW OF THE HENNEBIQUE PILE SYSTEM.

is given to its head in the shape of a cap to take off the blow of the monkey.

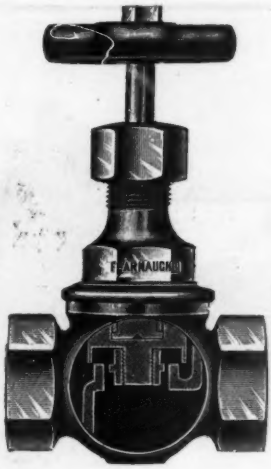
The Hennebique system is also applicable to superstructures, the columns taking the weight of floors being moulded in a similar way.

It is claimed for the Hennebique system that piles of this construction when once driven and connected with the superstructure, present a watertight wall without a single horizontal joint, able to resist pressures far in advance of those which any tides would possibly exert. The concrete piles possess obvious advantages over those of timber in other directions, and it is not surprising that the Hennebique system should be attracting considerable attention in engineering circles.

A BRITISH-MADE VALVE.

A YEAR or two ago, a number of foreign valve makers threw upon the English market a vast quantity of foreign-made valves which, owing to the large profits they offered to merchants and factors, had for a period an extensive sale. These valves, however, were of a light if cheap character, and unfitted for heavy engineering purposes. A want soon became perceptible for a valve of a superior description, and the firm of Messrs. Gaukroger, Sykes & Roberts, Ltd., of the Providence Brass and Iron Works, Halifax, seized the opportunity to bring out a valve more in accordance with the requirements of engineers and manufacturers. This was a much heavier valve, fitted for the most varied and most exigent uses, and within a short time its success was such, that Messrs. Gaukroger, Sykes & Roberts inform us, it has taken their utmost endeavours ever since to keep pace with their orders.

The "Fearnaught" valve, which they have entitled it, and which we illustrate in section herewith, has been subjected to the severest tests it has been possible to devise, and has never been found to show the minutest fault in working. They are made of specially prepared gun-metal with asbestos packing, are suitable for high or low pressures, and not liable to be injured or affected by sand or



SECTIONAL VIEW OF
THE "FEARNAUGHT" VALVE.

grit. The discs, which are renewable, are supplied either of a special composition or of white metal; there are no grinding seats, and the valves are always tight under pressure. The makers request that, where other valves have failed or proved unsatisfactory, a "Fearnaught" should be tried in place of them.

HAMPDEN BRIDGE OVER THE KANGAROO RIVER.

In the Annual Report of the Department of Public Works of New South Wales for the financial year, 1897-8, there is given a description and two views of the Kangaroo Valley Suspension Bridge, which we illustrate on p. 70. This bridge, which is known as the Hampden Bridge, is worthy of notice, not only for its elegant design and its harmony with the surrounding scenery, but also from the fact of its being the first suspension bridge of any magnitude constructed by the department. The bridge carries the Moss Vale-Nowra road over the Kangaroo River. In most cases where large bridges are required in New South Wales, the natural features of the site do not lend themselves to this type of structure. In the present instance, however, where the Moss Vale road crosses the river, the precipitous banks rise to a height of 70 feet from the river-bed. The difficulty of obtaining a foundation in the river, and the occurrence of excellent building stone on the site, led to the adoption of the suspension system. Fig. 1 of our illustrations gives a general view of the bridge and the valley which it spans; whilst fig. 2 is an end view, showing the towers and roadway. It will be seen that the bridge consists of a single span, which is 252 ft. 9 ins. wide, with a roadway 18 ft. wide, supported by 28 steel wire ropes formed into four groups of seven each, there being two groups or cables on each side of the bridge. The ropes which constitute the cables were specially manufactured for the bridge. They are of plough steel, galvanised, and contain 42 wires each. The specification provided that each rope should be capable of sustaining, without fracture, a load of 78 tons. When tested they sustained from 84 to 90 tons without a break. The roadway platform of the bridge is of tallow-wood, and the stiffening trusses of local iron-bark. Whilst these timber portions will, in the course of years, need renewal, the remainder of the structure may be considered as being practically permanent. The towers which carry the cables are built of sandstone, and are 55 feet in height. They are very massive in appearance, whilst a transverse masonry arch connects the pair of towers at each end over the roadway, forming an effective entrance to the bridge, as will be seen from fig. 2 of our illustrations. The height from the decking of the bridge to the underside of the arch is 18 ft., whilst the height of the decking above the summer water level of the river is 63 ft. The anchorage chambers in which the cables are secured have been sunk in the solid rock, and are so arranged that the cables can be inspected at any time, or renewed should renewal become necessary. Apart from its utility, the Hampden Bridge adds a pleasing feature to what has become in the colony a popular tourist route. The total cost of the bridge was £7,612 10s. 1*d*.

A limited number of the First Volume of FEILDEN'S MAGAZINE, magnificently bound, will be ready early in the year. The first opportunity of securing these we offer to Subscribers commencing with the New Year's issue.

As an extraordinary demand is anticipated early application for full particulars should be made to

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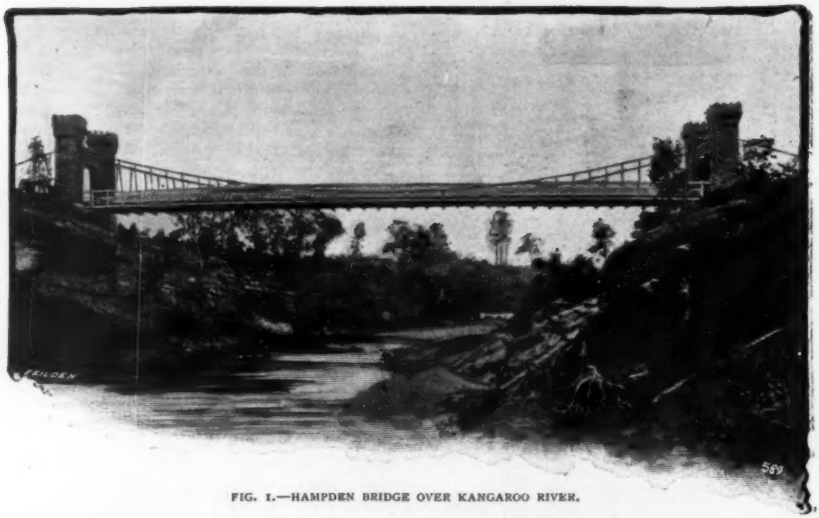


FIG. 1.—HAMPDEN BRIDGE OVER KANGAROO RIVER.

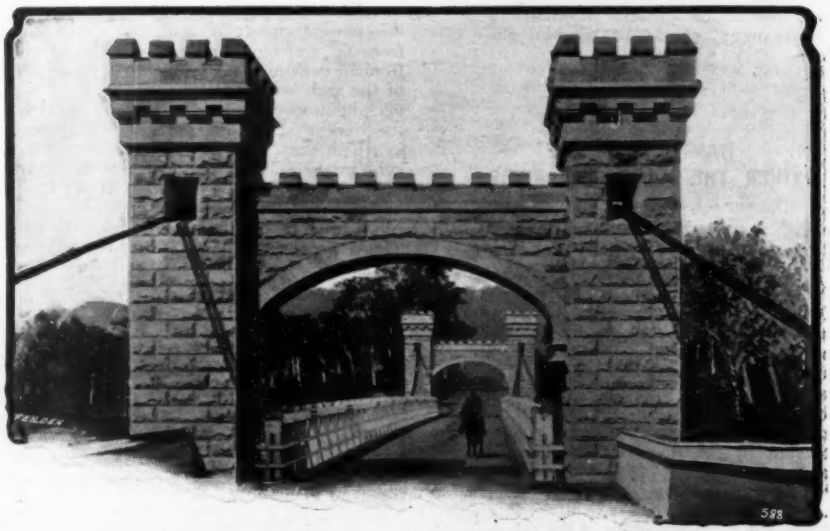
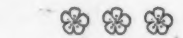


FIG. 2.—HAMPDEN BRIDGE OVER KANGAROO RIVER, VIEW SHOWING ROADWAY.

RECENT MILITARY EQUIPMENT FOR SOUTH AFRICA.



ONE of the chief drawbacks in connection with the use of heavy artillery in the field has consisted in the difficulties attending the rapid and effective transport of the guns. Already the operations in South Africa have conclusively shown that the steam engine has become an indispensable adjunct of military traction, and has revolutionized warfare almost as completely as it did other methods of transport earlier in the century.

It is therefore with interest that we are able to present some further particulars of recent machinery, despatched to South Africa, which has been designed to secure the important element of mobility in connection with the bringing up of guns and stores to the front.

The chief member of the Armoured Trains which have played so important a part in South Africa is the armoured wagon, a type of which we are able to illustrate (Figs. 1 and 2) by the courtesy of the Birmingham Railway Carriage Company, Ltd., who have supplied some hundreds of these to the Natal Government. These wagons are put together in the shops as illustrated, but the rivetting is not completely finished owing to the fact that they have to be taken to pieces for packing. Each car, which is armoured with Siemens-Martin steel about ¼ in. thick, has an inside length of 36 ft. 1 in., and is 7 ft. 3 in. in width. The height inside is 3 ft. 1½ in., and the distance between the centres of the bogies is 24 ft. Each wagon is fitted both with vacuum and hand brakes, and possesses a weight of 12 tons.

On arrival in South Africa they are fitted with a further steel structure, consisting of plates, which are superadded at an angle slanting inwards, and serve as an additional protection.

These upper plates are then pierced with loop-holes for rifles, and the wagon is in complete fighting trim. Each car is manned with a complement of 60 men.

For the transportation of the stores of all kinds and the haulage of heavy guns, by the advice of Colonel Templar, R.E., Director-General of Steam Transport, the Government have sent out numbers of traction engines, some types of which we are enabled to illustrate. These engines have been made by the well-known firm of Messrs. Fowler & Co., of the Steam Rough Works, Leeds, who have had considerable experience as to the peculiar adaptation of road locomotives to fit them for colonial requirements. Their representative has made a special study of the matter on the spot.

Fig. 3 is an engine supplied for Koffyfontein. It is fitted with side-by-side cylinders 6½ in. by 11¼ in. diameter; stoke 12 in.; the boiler being specially adapted for the South African coal, and a working pressure of 180 lbs. per sq. in. The tanks hold water sufficient for the requirements of a 12 mile journey with a load of 25 tons.

A type of this engine, modified in respect to adequate protection from dust storms, has

FIG. 1.—LONGITUDINAL VIEW OF AN ARMOURED WAGON SUPPLIED TO THE NATAL GOVERNMENT RAILWAYS BY THE BIRMINGHAM WAGON AND CARRIAGE CO. LTD.

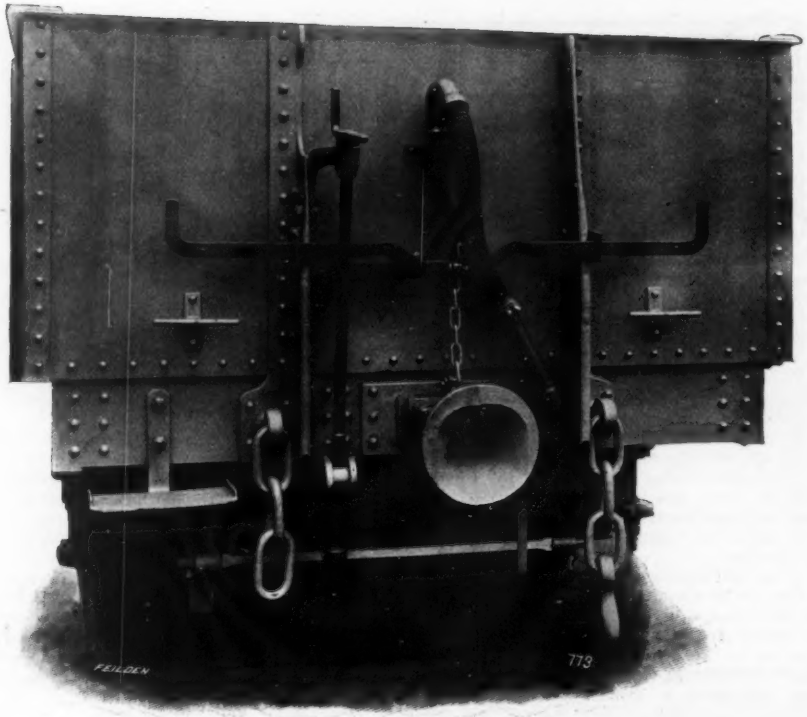


FIG. 2.—END VIEW (ENLARGED) OF ARMOURED WAGON SUPPLIED TO THE NATAL GOVERNMENT RAILWAYS.

been supplied in large numbers to both the Free State and the Transvaal.

Fig. 4 is an engine supplied for the Uganda Railway. The modifications in this machine consist in the increased tank capacity, the addition of dust covers, iron enclosed cab for protection against overhanging branches of trees when the engine is working through the bush, petroleum firing apparatus in addition to a furnace for burning coal and wood, a 15 cwt. Pollard crane and a five-ton jet crane. The engines are mounted on springs on the back end only.

Three engines of this class, with the additions of spring gear on the front as well as the back wheels, and a patent locking-gear for varying the road speed, were supplied for the Army Service Corps as far back as 1898, and three more were sent out immediately before the commencement of hostilities. They can travel at the rate of 8 miles an hour, but this speed can be increased to 12 miles when necessary to get out of the way of the enemy.

Immediately after the outbreak of the war five more engines of the above type were sent out, together with four powerful traction and winding engines adapted for ploughing, one of which is illustrated in fig. 6.

The cylinders of these engines are 8 in. and 14 in. diameter by 14 in. stroke. Horizontal drums are provided, each capable of giving off from 500 to 1,000 yards of wire rope $\frac{7}{8}$ in. diameter.

These engines are intended for use in steep places and for hauling loads over rivers and swamps. But their chief purpose is to haul a trenching plough, an illustration of which is given in fig. 5.

These remarkable machines will be utilized for the construction of shelter trenches. As may be readily imagined from the effective illustration we present, enormous power is required to enable this cutting to be

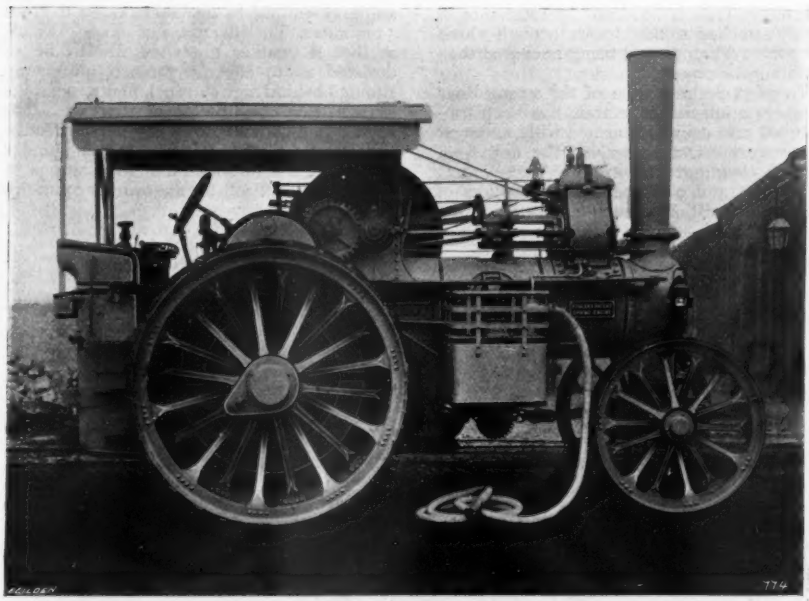


FIG. 3.—TRACTION ENGINE SUPPLIED BY MESSRS. FOWLER AND CO. FOR SOUTH AFRICA.

FIG. 4.—TRACTION ENGINE SUPPLIED BY MESSRS. FOWLER AND CO., ORIGINALLY FOR THE UGANDA RAILWAY, BUT SUBSEQUENTLY FOR THE ARMY SERVICE CORPS IN SOUTH AFRICA.

effected. This is attained by means of a pulley attached to the plough through which the rope works, one end being anchored thus doubling the power.

To effect the reduction of the strong Boer defences a special siege train has been constructed and equipped, armed with, amongst other weapons, a battery of the new 6-in. Breech-loading Howitzers. These guns (Figs. 7, 8, and 9) present some features of unique interest, inasmuch as they are the first weapons in which the operations of loading *and* firing can be effected at so acute an angle as 35 degrees. They throw a steel shell 6 in. in diameter by 20 in. in length, charged with Lyddite, effectively at a range of 5,200 yards with a muzzle velocity of 777 foot seconds. The primary feature of these guns, however, is not so much the length of range as the extreme angle at which the projectile leaves the muzzle, this angle extending to as much as 69 degrees 57 minutes. The advantage of this is obvious, in that it enables the shell fire to be so directed as to effectively reach an enemy situated behind high entrenchments, rocks, &c.

It will readily be seen, therefore, that such a gun should prove singularly effective against the Boer method of fighting under the protection of rocks, and in positions in which it is difficult for an ordinary gun-fire to reach.

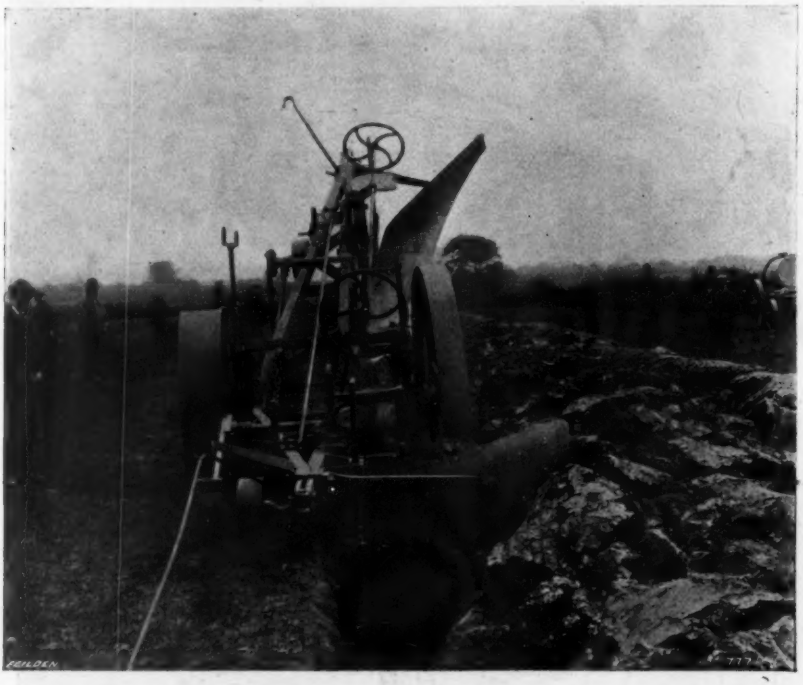


FIG. 5.—THE TRENCHING PLOUGH. THIS VALUABLE AUXILIARY TO THE MILITARY ENGINEER CAN CUT A SHELTER TRENCH BY SUCCESSIVE FURROWS 30 IN. DEEP AND 30 IN. WIDE.

From the accompanying photograph and diagrams it will be noticed that the breech is heavily protected. This is on account of the inordinate strain on this part of the gun, arising from the use of cordite, which being a quick-burning powder, the whole force is exerted at once instead of developing gradually, as in the case of the ordinary or slow-burning powders used in longer guns.

The following are the more important constructional details of the gun :—

Material		... Steel.
Total length		... 94 inches.
Weight		... 78 cwt. 3 qrs. 5 lbs.
,, of Breech Fittings		... 1 cwt. 2 qrs.
Bore—Length		... 84 inches.
,, Calibre		... 6 inches.
Chamber	Diameter	6·4 inches.
	Length	... 6·7 inches.
	Capacity	229 cubic inches.
Rifling	System	... Polygroove, hook section
	Length	... 74·7 inches.
	Twist	... Uniform, 1 turn in 15 calibres.
	Grooves	... 24 each ·6 of an inch in width, and ·05 of an inch in depth.
Firing mechanism		Electric and friction with T-tubes.
Venting		... ... Axial.

The gun consists of two tubes—one of which is shrunk over the other—and a jacket. The tubes are fastened longitudinally by means of corresponding shoulders and a steel breach bush which is screwed into the outer tube at the rear. The breach bush is prepared for the reception of the breech screw. The jacket is shrunk on over the outer tube and secured longitudinally by shoulders and a screwed steel ring at the rear. The breech ring, which is fixed over the jacket by means of screws, is furnished with lugs for the attachment of the howitzer to the hydraulic buffers of the carriage, and for the attachment of the breech fittings. A sight ring prepared for the reception of the fore-sight brackets is shrunk round the outer tube in front of the jacket and secured by means of a set screw.

To act as guides for the howitzer when in the cradle longitudinal projections on the side of the jacket are provided.

The chamber is cylindrical, slightly coned at the entrance, and terminates in front with a curved slope.

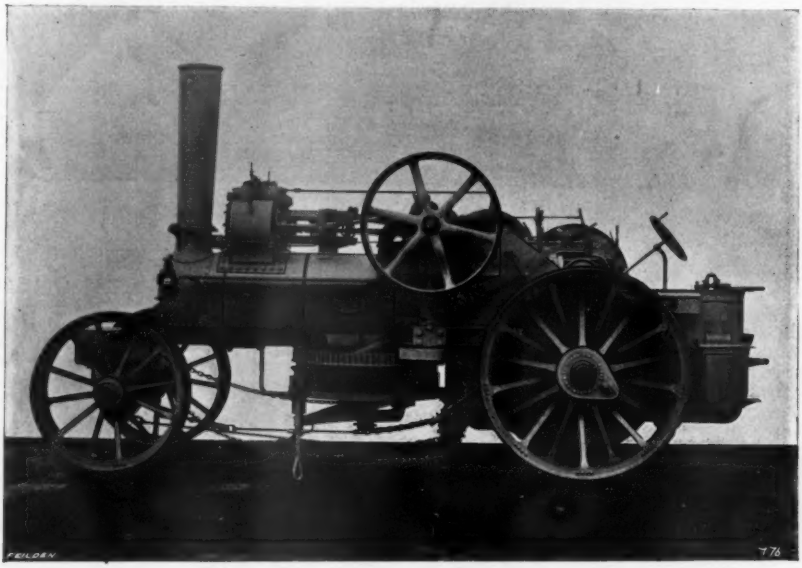


FIG. 6.—TRACTION AND WINDING ENGINE BY MESSRS. FOWLER AND CO. ADAPTED FOR HAULING LOADS OVER RIVERS AND SWAMPS, AND FOR WORKING THE TRENCHING PLOUGH.

The breech is closed by a screw having three portions of the screw thread removed longitudinally, the interior of the howitzer at the breech being prepared in a similar manner, admitting the breech, which is locked by the sixth of a turn, effected by a cam lever.

When the breech screw is pushed into the howitzer, an obturator, consisting of a circular elastic pad, enters the chamber, which, on

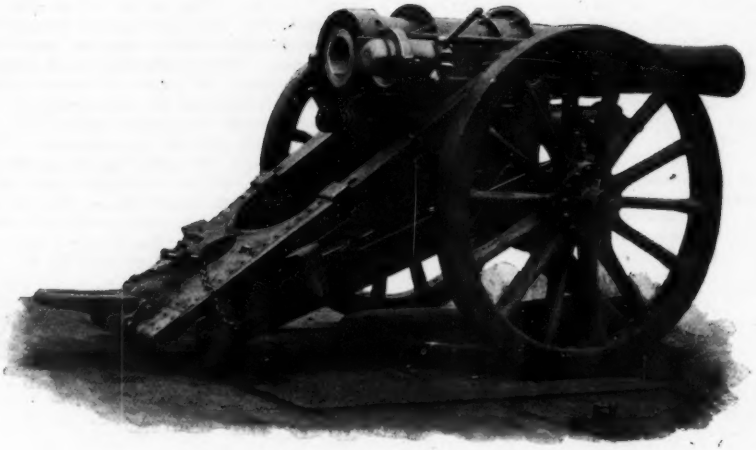


FIG. 7.—VIEW OF THE 6-IN. BREECH-LOADING HOWITZER, SHOWING BREECH MECHANISM.

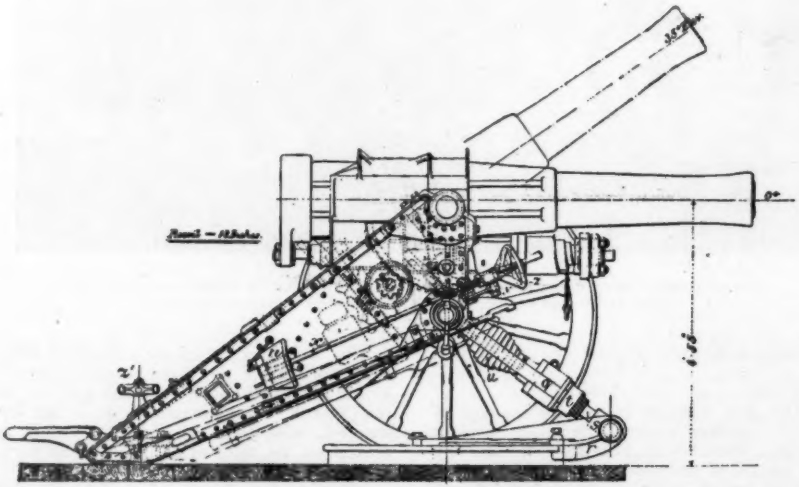


FIG. 8.—SECTIONAL VIEW OF THE 6-IN. HOWITZER, SHOWING THE RELATIVE POSITION AT POINT-BLANK AND AT AN ANGLE OF 35 DEGREES ELEVATION.

FIG. 9.—THE 6-IN. BREECH-LOADING HOWITZER IN FIRING POSITION.

turning the breech screw, is pushed home into the coned seat of the howitzer by the travel of the screw. The bore is thus perfectly closed all round the circumference. On the gun being fixed the pad is compressed against the breech screw, causing it to expand laterally, thus preventing any escape of gas.

The carriage is constructed to permit of the howitzer being fired at angles varying from point blank to 35 degrees. The gun recoils axially in a cradle, which is fitted with hydraulic buffers to limit the recoil to 18 inches.

Powerful springs return the gun into firing position, and an anchoring buffer for checking the recoil of the carriage when firing with the wheels on is held in a stay (*q*) attached to the axletree, which brings the gun to rest in a recoil of about 5 in. On firing, the tube (*t*) (Fig. 8) is drawn with the carriage by means of the stay (*q*), checking the recoil, and compressing the springs (*u*). A particular feature of this mounting is that this carriage can, with the addition of the top carriage and the removal of the wheels, be used as a howitzer bed by merely securing the gun to the double-decked platform.

This top carriage serves an important purpose, as when connected to the siege carriage an elevation of from 35 degrees to 70 degrees can be obtained, athough at this extreme elevation the range, with a full charge (14 oz.) of cordite, is reduced to 3,300 yards.

The projectiles used with this gun are :—1, common cast steel ; 2, a forged steel shell similar in form and dimensions to the common shell, but containing a bursting charge of Lyddite.

Lyddite, with which the shells are charged, is named from the town of Lydd in Kent, at which place the Government first made and experimented with it. This is one of the picrate powders having picric acid as a base, to which group also belongs the French explosive, Melinite. Although its powers have been sufficiently proved in the Transvaal, its destructive energy was very effectively demonstrated in the incident of the destruction of the Mahdi's tomb by the Sirdar in the recent Soudan campaign.

The siege train is further provided with eight 4·7 in. Naval guns, with an effective range of 10,000 yards, of the same class as those used by the Naval Brigade at Ladysmith.

WORKSHOP PRACTICE

Under the above heading we are introducing a new section to FEILDEN'S MAGAZINE, the purport of which will be to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is much more generally encouraged by employers in the workshops of the United States than in Great Britain; and, moreover, the American technical press also devotes special attention to ideas and improvements suggested by artizans. In introducing this section of the Magazine, the Editor invites skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which if accepted will be paid for. Whenever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for reproduction. Nothing will be too poor for a careful inspection.

Below we give a few examples of American practice indicating to some extent what is required.

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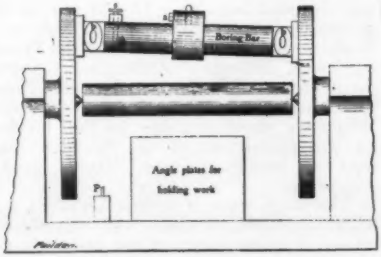
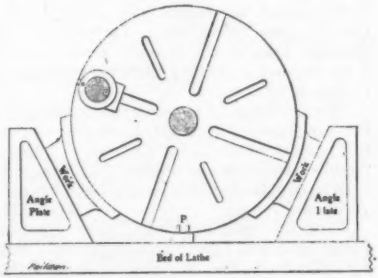
A Taper Boring Rig.—When designers put the dome on the taper course of a wagon-top boiler they evidently do not think of the shaping of the reinforcing ring which must fit the sheet, or that a special boring rig may be necessary. These rings are usually planed out on a planer having a special head with a circular movement, but the taper has to be treated differently. At the Baldwin works we recently saw a big wheel lathe doing duty as a boring mill for this work in a manner that was both ingenious and extremely practical. A heavy centre bar or distance piece was between the centre as a brace, and the boring bar bolted by special foot pieces to the face plates at the proper distance for the radius and at the correct angle. The work—and two rings were being bored at a time—was held on angle plates, as shown by the end view, and fed into the proper distance. The foot pieces for the bar had two ears or lugs, between which was bolted the flattened ends of the bar *bb*, so that any desired angle can



TAPER BORING RIG.



TAPER BORING RIG.

be obtained. The boring bar is of the usual type, although with slight modifications, and the star wheel *s*, striking pins *P*, feeds the tool head along in the usual manner.—*Locomotive Magazine.*

Tie-Spotting or Grooving Machine.—When railway ties have been badly cut by the rails, the rail seat must be cut level with an adze, in order to form a proper bearing for the old or new rails,

or for tie-plates, if these are to be applied to old ties. In such work the trackmen have usually to rely upon their eyes in getting a level and even seat, and while practical men are very expert, yet there is no guide to which they can work. As the ties are more or less covered with dirt and sand, and the men are hurried, the work is very often imperfectly done. If the foreman should take time enough to ensure the work being well done, he is liable to be censured for getting so small an amount of track relaid. Mr. George M. Brown, Chief Engineer of the Flint & Pere Marquette R. R., has invented a machine for grooving the ties to the required depth, the grooves forming a gauge or guide to the men in adzing the ties. This machine has been employed successfully on about 100 miles of standard gauge track this year, and on 110 miles of narrow gauge track which it was intended to change to standard gauge last year. The machine, Fig. 1, is mounted between two flat cars. On the rear car is mounted an engine with a cylinder about 12 by 20 in., taking steam from the locomotive which pushes the cars along the track. Over the front end sill of the rear car is a shaft carried in timber frames bolted to the floor. On this shaft are keyed a 20 in. and a 40 in. pulley, while journalled upon it are the side timbers of a rectangular frame which projects ahead of the car. The front end of this frame is supported by a pair of 26 in. wheels, the distance from the driving shaft to the axle of these wheels being about 9 ft. 9 in. In front of the frame, and supported by iron brackets, is a shaft extending across the track and carrying four sets of four 24 in. saws. The two outer saws of each set are vertical, but the others are inclined, or set diagonally on the shaft, so as to cut out the wood between the two outer saws. The shaft is raised and lowered in guides by means of screws with sprocket wheel heads connected by a chain. These saws cut four rectangular grooves across the ties, the width being about 2½ in., and the depth being sufficient to reach below the worn part of the rail seat. This is shown in Fig. 2. When the rails are removed it is easy for the trackmen to adze out the intervening wood, level with the bottoms of the grooves. Part of this adzing may be done before the rails are removed. On the rear end of the front

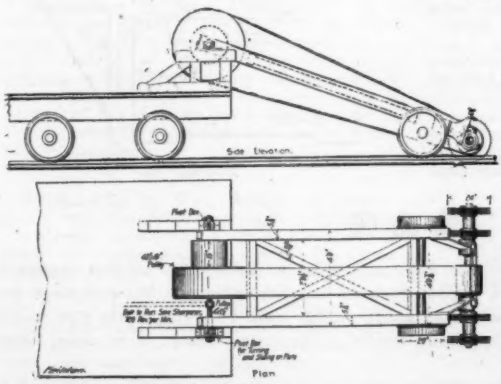


FIG. 1.—TIE-SPOTTING OR GROOVING MACHINE.

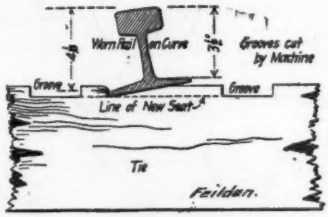
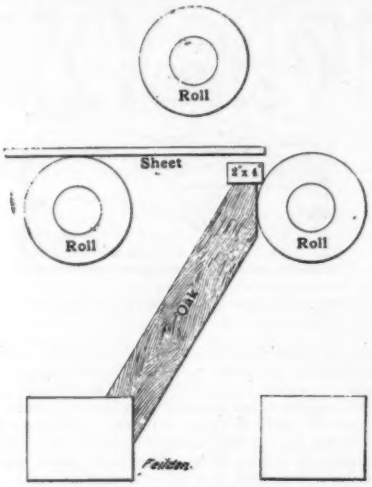


FIG. 2.—TIE-SPOTTING OR GROOVING MACHINE.

car is a derrick frame and hoist, with chains attached to the front end of the frame carrying the saws. In this way the frame can be raised when the machine is not required to work, or in order to clear the rails at frogs, turnouts, crossings, &c. The cars are coupled together by two heavy timber beams above the floor. The saws make about 1,500 revolutions per minute, and the machine is pushed or hauled over the track at a speed of about 3 miles per hour, or faster for ties of soft wood. The machine was built by the Wickes Brothers' Ironworks, of Saginaw, Mich. — *Engineering News.*

A Boiler Shop Kink.—In the Santa Fé Pacific boiler shop at Albuquerque they use a device for bending the end of a sheet under the rolls, so it will be of the same circle as the rest of the sheet, that is worthy of imitation. A long bar of 2 by 4 in. iron is laid next to the lower roll and braced up by a number of wooden supports, so the bar is firmly held up while the edge of the sheet rests on it. The upper roll being forced down by the screws at each end bends the edge of the sheet to the proper radius. The illustration makes this plain. Boiler shop foreman Alfred Parfitt is credited with this kink. There are other devices equally ingenious. To hold a bar or long chisel while cutting off staybolts, a rubber wedge is used, made of a short piece of 3 in. hose. When this wedge is put in it is flat and thin; after being placed it is inflated with air from a small hose and fills the space, holding the bar firmly in place for each blow of the air hammer. A small hydraulic jack, with the power furnished by water pumped with an air-brake cylinder, is a very handy device for lifting boilers to block up or turn over. This jack takes up very little room where it is set. A small

copper pipe connects it with a water supply attached to an air-brake cylinder, which is out of the way. The piston rod of the air piston serves as the plunger to force the water into the cylinder



BOILER SHOP KINK.

of the jack. When the weight is to be lifted, the air is turned on and the pressure is carried from the plunger by the copper pipe to the ram of the jack.—*Locomotive Magazine.*

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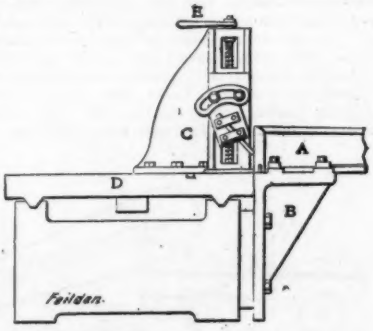
A Planer Job.—Automatic Feed by a String.—Several years ago I worked in a shop where frequently heavy jobs had to be handled with light tools. One of these jobs was an upright, shown in the sketch at *A*, lying on its side. The casting was about 10 ft. long and 72 by 18 in. at the base, which had to be planed off. There were a good many of these castings to machine at various times, and they were considered something of a nuisance, as there was no planer large enough to machine them in the ordinary way, and no travelling crane to handle them. They had to be towed across the shop on a four-wheel truck of altogether too small dimensions for such a load, and this operation required the services of several strong labourers, those not actively engaged in the hauling supporting the unwieldy load at the sides to prevent its listing dangerously. The sketch shows the planer from the rear end, the planing operation being performed back of the uprights, which are not shown; the tool, of course, cutting on the slow travel of the table. The angle iron *B* was fastened to the side of the planer, and to this angle iron the casting was strapped; the outer end, not shown in the sketch, being supported by blocking from the floor. The casting *C*, which was fastened to the planer platen *D*, had a tool slide fitted to it, operated by the vertical screw seen in the sketch. The casting *C* was, of course, well braced at the rear, as well as sideways, in order to stiffen it, and was tongued to facilitate in locating as well as in holding it on the table. For some time it was customary for the man running this job to ride back and forth on the table, feeding the tool by hand. Finally, someone who tired of this somewhat monotonous job, put a ratchet drill, the handle of which is shown at *E*, on the feed screw and tied two pieces of strong cord to the handle, then carried one cord in each direction parallel to the planer ways, and fastened the ends to beams overhead. One cord was of such a length that as the table neared the end of its forward run the cord tightened, drawing the handle around far enough to give the desired feed. As the table ran back the opposite cord tightened, pulling the ratchet handle back in position to give the feed at the end of the next forward run.—*American Machinist.*



A PLANER JOB.

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With this issue is presented the Title Page and Index to Volume I., so that readers of FEILDEN'S MAGAZINE will now be in a position to have their copies bound. We announced that prices and particulars of Binding Cases would appear in this issue, but owing to the phenomenal number of applications received, it has been decided to produce a design even more superb than was originally intended.

Two covers, one in cloth and the other in half-roan, are in rapid preparation, and will be ready early in the month. Full particulars and prices will be sent on application to the Publisher.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

CIVIL AND MECHANICAL ENGINEERING.

Flexible Driving.—What is described as a novel application of the flexible shaft principle has been in successful operation in the propelling of the small pleasure craft in Berlin. The motive power is a 2-h.p. vertical naphtha engine, taking up but little room in the stern of the boat. This engine transmits the power to the propeller through a flexible shaft passing through a curved steel tube, leading over the stern of the boat. This curved tube, besides carrying the propeller at its end, is also fitted with a rudder, and is moved by a tiller. The whole apparatus can be quickly fitted to any small pleasure boat.

Failure of Compressed-Air Traction.—It is stated that the compressed-air cars, for some time in service on the street lines of the Metropolitan Street Railway Company in New York, are to be given up and replaced by the surface-contact system. The reason assigned for the change is that the compressed-air cars are too noisy and not economical.

Aluminium for Steel Making.—We see it stated in the United States Press that the Pittsburgh Reduction Company are experiencing an active demand in aluminium for steel-making purposes in the United States, one sale for this object being a quantity of two tons. We have not noticed any great attempt to push the sale of British-manufactured aluminium for the same purpose in this country.

Engineering in West Africa.—A contemporary states that the greatest engineering scheme ever devised on the West Coast of Africa is now practically completed at Lagos, where the Carter Bridge, over half a mile long, has been stretched across the deep Lagos Lagoon to Iddo Island, and the Denton Road and Railway Bridges have spanned the remaining space between Iddo Island and the mainland. The workshops on Iddo Island have been busy for the last three years upon this great work, the difficulties of which have been very much enhanced by the absolute dearth of skilled labour and appliances in such an out-of-the-way region. The Lagos Government Railway, which forms part of the scheme of the late Governor, Sir Gilbert Carter, has made amazing progress during the past twelve months, and is now open to Abeokuta, that wonderful city of 150,000 souls, and is rapidly approaching Ibadan, an even more remarkable city of 180,000 people. The quantity of trade likely to result from the tapping of this district, of which Abeokuta and Ibadan are but two of the many native towns, can readily be imagined. Here again, however, the cry is for still further enterprise. The railway should not and cannot be permitted to stop at Ibadan. Is not the River Niger but a few score of miles further, and beyond that is there not that wonderful land Nigeria, with its great markets of Sokoto and Kano? Truly the Colonial Office has undertaken a great work, and once having put its hand to the plough it will be difficult to turn back.

Coke Ovens and their Waste Products.—Although a good deal is being said about the utilisation of the waste gases of blast furnaces, we hear little or nothing respecting the heat and gases going to waste in coke ovens. It is stated, however, that in two plants at Tracy City, Tennessee, the gases from double rows of beehive ovens are thus utilised. Tests made there by C. E. Bowron showed that about 15 per cent. of the total heat units given out in the coking process find their way into the water in the boiler. At the Pratt Mines, Alabama, where beehive ovens are used, a flue was built in the filling of the ovens, and conveys the gases to two batteries of boilers, where it replaces about 1,500 tons of coal per month. Each flue is connected to the main flue by a 12-in. passage, and in some instances the steam-pipes are laid over the flue to prevent condensation. The system does not injure the quality of the coke made, and the smoke about the ovens is lessened, while more steam is raised than when the boilers were coal-fired.

Irrigation in South Africa.—Boring for water will become an important industry throughout the major portion of South Africa when the normal condition of the country is resumed. The first

bore for water was made in 1890, a diamond drill being employed, and from that time the Government has carried out the work, charging the farmer a less price than if he had owned the drill. It has been estimated that a successful bore made by the Government costs the farmer £19, against £29 when he does the work himself, and more successful results have been obtained. The result has been, for 1898 alone, to add 3,000,000 gallons to the daily water supply of this colony. The Government has been inundated with applications, and with the present supply of drills the work can not be done fast enough. It is expected, so says the United States Consul, that by the time the applications now on hand are taken care of, 1,000 more will be waiting. There is an excellent supply of underground water almost all over the colony, at a reasonable depth below the surface. Several dams are being built, and in one over 1,400,000,000 gallons have passed through the sluices, and there is still sufficient water to fill the dam when completed. The wells being bored will need pumping appliances of various kinds, and windmills appear to be the most inexpensive; those that have arrived having been readily sold. The Government may yet assist the farmers in purchasing such appliances. In 1898 there were 19 Government water drills at work; 206 applicants were served and 547 applied; 367 bore holes, 10 feet or more deep, were made; 26,573 feet were bored, the drills (19) making an average of 1,399 feet each; 258 holes produced 1,000 gallons per day and upwards; and the estimated total yield of water per diem was 3,000,000 gallons. In 106 holes, water flowed to the surface to the extent of 783,000 gallons per diem; and by pumping, a supply of 2,217,000 gallons can be obtained from the other 219 holes. Recently, a large steam-power drill was purchased in England for the purpose of making a trial deep bore hole. The first boring, when between 120 and 171 feet from the surface, struck a supply of water yielding 21,400 gallons per diem, and a steam pump failed to lower it. Another bore has been made to the depth of 1,504 feet and discontinued, owing to the exhaustion of the special fund set apart by the Government.

ELECTRICAL ENGINEERING.

Electricity for Rural Industries.—An association of Farmers in the district of Ochsenfurt (Bavaria) is erecting, according to the *Elektrotechnische Zeitschrift*, a large electrical works near the village of Bütthard, in Lower Franconia, which will be entirely devoted to agricultural uses. The current is produced close to the village of Schäftersheim, a distance of 11 kilos., requiring for its creation a force of about 150 h.p., which is supplied partly by steam and partly by water, and conducted as current of 5,000 volts to the villages of Bütthard, Laudenbach, and others, where it finds the most varied use. Movable electromotors for driving thrashing machines, chaff cutters, bruising mills, etc., are supplied, and connecting boards for the conducting wires are placed at every farm. The motors are of very simple construction and can be easily handled by any of the farm hands. Of course, the electric light will be most widely diffused through all those villages, and on account of greater security with regard to fire in the lighting of agricultural buildings is daily increasing in use among farmers.

The Long Distance Aluminium Electrical Conductor.—The installation of the electrical cable at Hartford, U.S.A., to which we have referred previously, is now approaching completion. The cable has seven strands and a diameter of ¾-in. It weighs about 1,500 lbs. to the mile, or nine tons for the whole line. The cable is not insulated, as is the copper cable which brings the 10,000-volt current from the Poquonock power house. The poles are short and very strong. No trouble is apprehended from weather conditions, as the cable is so light and strong that no amount of snow or ice which may accumulate on it in winter is likely to break it. The cable has been furnished by the Pittsburg Reduction Company, and its use in Hartford will be the first practical electric test of aluminium on a large scale and over so long a distance.

Electrical Plant in Lima.—The French Minister at Lima recently informed his Government that several French electrical engineers and mechanics resident in Peru had solicited the aid of the Legation for the purpose of obtaining catalogues relative to the articles in their special line of business. These requests refer principally to lighting materials, wires, flexible cords, sockets, lamps, generators for the transmission of electric power, telegraphic and telephonic apparatus, etc.

American Manufacturers and Glasgow.—New York *Electricity* says: "After being carefully guarded for over two months, it has just leaked out that the Tramway Committee of the Glasgow Corporation has awarded the contract for the supply and laying of the conduit for conveying the cable for Glasgow municipal tramways to the National Conduit and Cable Company, of America. The work of laying the pipe, under American supervision, has already begun, and some 500 navvies are being employed. This conduit contract is reported to be by far the most important one ever placed outside of England. Already 2,000,000 ft. of piping have been ordered, and it is said that the chances are that the entire requirements in this line will be filled by the Americans, and that the cable—on the superior manufacture of which English manufacturers have long prided themselves—will also be ordered from the United States. The curious part of the conduit contract is that a lump sum has been agreed upon by the National Company, that will include the supply of pipe, the excavating of the earth, as well as the laying of the pipe. The awarding of such a contract to a foreign firm in a

city where the contractors have long been considered *par excellence*, may be regarded as a telling testimony in favour of American enterprise. The Glasgow Corporation is in the market for brick-making machinery.

German Electrical Companies' Dividends. —The trading results of some of the chief German electrical engineering houses for the past year are interesting. They are as follows :—

		Total Capital. £	Net Profits. £	Dividend. p.c.
Siemens and Halske ...	1897-98	1,750,000	276,553	10
Allgemeine Elektricitäts-Aktien-Gesellschaft ...	1897-98	1,750,000	342,657	15
Allgemeine Elektricitäts-Gesellschaft	1898	270,000	...	15
Ganz & Co.'s Maschinenfabrik Actien Gesellschaft (Buda-Pesth) ...	...	240,000	101,983	25

Belgian Electrically-operated Dredge. — A description has been published of an electrically-operated dredge, made in Belgium for the Russian Government, to be used in widening and deepening the River Volga. It is stated to be of wonderful power and adaptability, mainly owing to the employment of electricity in its manipulation. The three-phase alternating current system is employed, permitting cheaper and lighter machinery and promising less trouble in maintenance than the direct current, although it brings with it some difficulties peculiar to itself. The vessel is provided with two hulls, in each of which a 600 kilowatt, 5,540 volt, 24-pole generator is driven by an 800 indicated h.-p. marine engine, directly connected, running at 200 revolutions. The current from this generator is led to four motors on the dredge and to two on the end pontoon. The former are all alike, being rated at 125 h.-p., having twelve poles and running at 400 revolutions. Each drives directl, a four-bladed propeller 46 in. in diameter. Two of these are at the stern, and the other two are in recesses in the sides of the hull, well forward. The pontoon motors are of 30 h.-p. each. They have ten poles and run at 480 revolutions, with their shafts coupled directly to propeller shafts carrying 20 in. three-blade propellers. All of the motors are of the induction type. The generator supplies two stern motors and two bow motors, each of 125 h.-p., driving four foot screw propellers. The generators also supply power to 39 h.-p. motors mounted in the distributing pontoons, and are also arranged to control the position of the pontoon line as required by operation. Lighting is done from a separate installation. The engine for driving the electrical generator is of the usual triple expansion vertical marine type. The cylinder diameters are :—High pressure, 14¼ in. ; intermediate pressure, 22⅜ in. ; low pressure, 37⅜ in. ; stroke, 24 in. The diameter of main shaft is 7⅜ in. ; the indicated h.-p., 800 ; revolutions 200 per minute ; the total weight of engine is about 25 tons. A large governor acts on the valve gear of the high pressure cylinder regulating the speed. One feature of the dredge which is said to have given great satisfaction is the installation of water-tube boilers, which are of the Babcock and Wilcox marine type. There are four of these boilers on each hull half, making eight in all, with a total heating surface of 17,200 sq. ft. In addition to this, a small boiler of the same construction is fitted in a "stern-wheel" steamer, which acts as a workshop and general tender to the dredgers. This boiler has 1,000 sq. ft. of heating surface. The boilers are fired exclusively with naphtha. There are four burners fitted to each boiler in the dredge and two in the stern wheeler. The spraying of the naphtha into the furnace is accomplished by means of a steam jet. As the dredge is self-propelling and self-controlling, the electrical features have manifestly added enormously to its effectiveness and have minimised as much as possible interference with commerce.

The Drainage of New Orleans: New Employment of Electrical Plant. — A new system of drainage has been adopted for New Orleans that shows some remarkable features. The centrifugal pumps used are worked by high tension electricity from one central station. The main canal has been divided into five sections, and an artificial slope given to each so as to cause the water to flow. Powerful pumps, connected direct to horizontal motors, pump the water from the end of one section into the beginning of the next. The power-house building is complete, and 1,800 h.p. is at present supplied to three of the stations by means of three-phase currents conveyed on overhead wires at a pressure of 3,300 volts. The wires are for the greater part of their length bare. Over swamp land square poles 40 ft. long are driven 30 ft. into the earth, and the electric poles are bolted on to them. The entire system of drainage is thus controlled from one point. This is, in many respects, preferable to individual steam pumping stations. The ultimate power required for the seven pumping stations will be just over 4,900 h.p. The efficiency of the entire system of distribution is calculated to be between 50 and 60 per cent. of the power generated at the central station.

Electric Rail Welding.—A description has been published in the *Electrical World*, U.S.A. of the electrical rail welding plant employed by the Lorain Steel Company of Ohio, now employed in making 7,500 rail joints in the Buffalo street railway system. The trolley wire current is transformed by a rotary converter carried on the car into single-phase current of 300 volts, and then down to 5 or 7 volts by a static transformer of one secondary turn giving up to 25,000 amps. The joint is made by means of fishplates welded on to either side of the web under heavy pressure. Each joint takes fifteen minutes to complete.

RAILWAY WORK.

New Railway Construction in Canada.—At the next session of the Dominion Parliament the Canadian Pacific Railway Company will apply for an Act authorising the construction or purchase of the following railways: from Deloraine, Manitoba, thence south-westerly to a point in Township No. 1 or 2, thence westerly 100 miles; from a point on the Manitoba South-Western Colonisation Railway between Manitou and Pilot Mound, in a southerly direction to a point at or near the international boundary; from a point on the last-mentioned railway in Township No. 1 or 2, thence easterly 50 miles; from a point in Township No. 1 or 2, between the Manitoba and South-Western Colonisation Railway, and a point at or near the international boundary, thence westerly 50 miles; from McGregor, on the company's main line in Manitoba, thence westerly and north-westerly to Varcoe, about 56 miles; from West Selkirk in a northerly and north-westerly direction to some point on the west shore of Lake Winnipeg; from a point on the company's main line at or near Molston Station, Manitoba, thence northerly and north-westerly to a point on Lac du Bonnet or Winnipeg River, about 26 miles; from a point on the company's line at New Westminster, thence to Vancouver, as may be found most direct and feasible.

Turkish Railway Concession.—It is stated that the Turkish Government have decided to grant a concession for the construction of the projected railway from Konih to Baghdad and Basra, a State guarantee being given to the Anatolian Railways Company. The agreement will not be signed till a later date.

The Pekin Syndicate and Shansi.—A report from the representative of the Pekin Syndicate recently made public contains some important details respecting prospective railway construction in Shansi, which lies within the area of the Syndicate's concession. For the development of its mineral resources, and the manufacturing industries it must necessarily create, it is estimated that some 570 miles of railway may be profitably constructed. The estimate of cost is of course an approximate one, and the whole cost is taken at £4,196,000. These railways would provide links of communication with the mines and the seaboard on the north-east of Tientsen and the south-east opposite to Nanking, making, with existing water communication, a total of 650 miles. A very liberal and carefully prepared estimate of the quantities of coal and mineral to be carried upon the railways gives the gross earnings at £1,166,000. A considerable amount of sidings will, of course, be necessary, and the gradients are stated to be in favour of the traffic, and heavy loads may, as a rule, be calculated upon. Over and above the mineral traffic which may be expected within the Province, further sources of lucrative business may be realised from the important branch of the line from Honan Fu westward through the gate of Central Asia to Si-an Fu, which is the old capital of China. The approximate estimate of the profits to be derived from the sale of the produce of the coal and iron mines, and the working of the railways—the latter worked at, say, 65 per cent.—would make a total of £1,650,000. The term of the concession is for sixty years, and a sinking fund—including interest charges—would require to set apart £371,000 for repayment of capital at the expiration of the term of concession.

Railway Construction in Siam.—A number of concessions for new railways in Siam have been granted. Among these is a line from Singgora, 200 miles south of Bangkok, to Kedah, 40 miles north of Penang, on the west coast of the Malay Peninsula, for which surveys were completed in October, 1892. It will be 200 miles long and tap rich mineral regions. Another projected line is to run from Bangkok to Ratburi and Petcharburee, a distance of 100 miles, which may be extended and made to form a link in the proposed Siam-China line. A line to Anghin, 40 miles south-east from Bangkok, and possibly on to Chantabun, 150 miles; another to Petriew, about 40 miles, and other shorter routes, are also mentioned among the possibilities.

Another Great Russian Railway Scheme.—The Russian Railway Administration has just decided upon the construction of a railway between Zarizyn and Orsk. This line had on several occasions been proposed and as often rejected, owing to the great engineering difficulties, which were supposed to be insurmountable. Now, however, the preliminary surveys have been successfully carried out by the engineering staff of the Wladi-Kaw-Ka-Railway, and the project submitted by them has been definitelv accepted. The estimate of cost provides for an expenditure of 120,000,000 roubles for the construction and equipment of the line. As this railway will traverse one of the most fertile regions of Western Siberia the freight traffic is expected to be an exceptionally heavy one. It is confidently asserted that within two years of the opening of the line at least 1,500,000 tons, consisting mostly of Siberian wheat and other agricultural products, will be carried each year.

TEXTILE INDUSTRIES.

British Textile Products in China.—A United States Consular Report says:—Great Britain, in hosiery as in other manufactures, maintains a characteristic and stubborn preference for home products and furnishes, with her colonies, the greatest developed market for British manufactures. For several years her exporters have assiduously cultivated the opening Chinese field, and they view with especial alarm the growing

success of American goods and methods in that territory. Said a manufacturer prominent in the Chinese trade :—

"As to German competition, we have no fears. In my own experience I have lost at times a number of Chinese customers through German underbidding, but in each case they had returned voluntarily, giving pretty shrewd trade reasons for doing so. They have an acute trading instinct, and must be satisfied that they are not only given bottom prices, but that the goods are exactly as represented. They are quick to detect any variation between samples and invoice; but once gain their confidence, and they are excellent customers in all respects."

Then he inquired : "By the way, are not you Americans making unusual efforts in the Chinese markets?" This last question voices the apprehension felt especially towards American competition, viewed in the light of a decrease of British exports, mainly of woollen and cotton, in 1897, of $6,500,000 to Brazil, $10,000,000 to Argentina, $8,500,000 to China, and $15,000,000 to British India, as compared with enormous American increases.

Nettle Fibre in Germany.—Nettle fibre has of late come greatly into favour in the manufacture of fine yarns and tissues in Germany. In that country, according to the United States Consul at Glauchau, there are factories which use these fibres, both in spinning and also for ulterior purposes. In nettle spinning alone, over 10,000 spindles and some hundred workmen are employed. The raw material is imported almost exclusively from China, whence some 660,000 to 800,000 lbs. are annually sent to Germany. Nettle fibre produces one of the finest tissues obtainable from any known kind of vegetable fibre. In view of the importance which this seems likely to attain in connection with the weaving industries, it is intended to introduce the cultivation of nettles, if possible, into the Cameroons. The idea is to prepare the products of this experimental culture at the place where they are obtained, and test them in German factories. Should favourable results follow from these experiments, it is intended to organise nettle-growing enterprises on an extensive scale.

New South Wales as a Supplier of Raw Cotton.—As the results of some extensive trials, it is declared that the cotton under cultivation in the 1898-9 season in New South Wales held its own with a fortitude and persistence that was truly remarkable, and the final results showed that cotton is entitled to a place in the front rank in the province as a drought-resisting crop. It vied with lucerne in remaining green and continuing to grow when all other vegetation was at a standstill, if not scorched and dead—even noxious weeds, and grass and trees in the nursery, and by the roadside, dying in their tracks for the want of water. While the yield of cotton fibre was small compared with what it would have been in a more favourable season, and while the experiment was not a shining success in itself from a business point of view, it was the very opposite of a failure in several important respects. The student of agriculture and of the climatology of plants, as well as the observing everyday farmer who is wrestling with the questions that affect crop production, cannot fail to see from the outcome of this trial of cotton-growing in the Colony that the crop is one of the surest in years of drought, whether generally profitable or otherwise. Mr. Howell (whose Report we quote from), who has been familiar with cotton culture from childhood, declares that the experimental effort furnishes every reasonable guarantee that lint-cotton of excellent type and quality may be numbered among standard productions of New South Wales.

German Textile Trade falling away.—The exports of textiles from Germany have never recovered fully from the great fall up to 1894, in spite of the jump in 1895, whereby much of the lost ground was made up. In fact the total has been falling for the last three years. The following are the values for the last six years :—

1893	£33,990,000
1894	£28,780,000
1895	£34,435,000
1896	£35,340,000
1897	£34,165,000
1898	£33,245,000

In 1890 the figures were £39,860,000, and in 1891 £35,295,000.

On the other hand, German imports of the same class of articles have risen very fast, as the following values will show :—

1895	£3,965,000
1896	£4,565,000
1897	£5,530,000
1898	£5,330,000

The German imports of textile machinery from England increased from £930,000 in 1897 to £1,041,000 in 1898.

Textile Plants in Paraguay.—According to a U.S. Consul there, fibre-producing plants of value are indigenous to, and grown in Paraguay. Cotton grows throughout the entire year, though after the first crop is gathered the plant is cut off at the base so that new shoots may spring from the roots and in turn come into bearing. After the second year the fibre becomes coarser, so that in order to obtain a fine grade it is necessary to plough up the ground and start a new crop from the seed. The Government is giving every encouragement to this industry. Another plant, "Sauceverde," is grown to a considerable extent in damp soils, and when gathered is nearly black, but, after passing through certain processes, the fibre becomes white and glossy, and is very strong. He is of the opinion that this plant might be employed in the manufacture of imitation silk goods. From the description furnished, it would appear that the plant is a species of ramie, known by the

local name quoted. "Caraguata" is another fibrous plant, having a more prolific growth than the "Sauceverde," and belonging to the family of *Bromeliaceæ*, a kindred species to the pineapple. It grows better in a wild than in a cultivated state, and as its leaves have many thorns it is very difficult to gather. Without special machinery it is almost impossible to free the fibre from impurities, but it well repays the trouble taken, being used by the natives for rope-making, and for this purpose is considered superior to jute.

MARINE ENGINEERING, &c.

Coaling Warships under Steam.—An apparatus has been devised and tested by the United States Navy Department for rapidly coaling warships when under speed at sea. The battleship *Massachusetts* was chosen for the experiments, and, having on board the experts appointed by the department to report upon the invention, towed the collier *Marcellus* out to sea. The vessels were connected for the purposes of the trial by a wire hawser, 300 ft. long, over which bags of coal, each weighing 410 lb., were trolleyed from the collier to the warship while the latter headed seawards. The work was carried out under various speeds, but rough seas prevented any test at the highest rates. Nevertheless, it was demonstrated that the apparatus could be used even under such conditions. On another occasion when the sea was smoother, and fairly average conditions of weather prevailed, coal was transmitted at a rate of 22 tons an hour, while a speed of five knots was maintained. The experts were so far satisfied with the demonstration that they unhesitatingly recommend Mr. Long to adopt the apparatus for use in the United States Navy.

Suggested British Steamship Service to the Gulf of Mexico.—It is stated by a shipping contemporary that one of the greatest needs for the development of British interests in Mexico is the prompt establishment of a direct and quick monthly service of first-class steamers between a British port and the Mexican Gulf, touching only at Havana, both on the outward and homeward journey. A steamer going some 13 or 14 knots could easily accomplish the journey in from sixteen to seventeen days, and the want of such direct communication, both for passengers and freight, is so manifest that any company starting such a line of steamers at reasonable rates, would earn very large profits. The present time is specially fitted for the introduction of such service, as the approaching Paris Exhibition would certainly fill such vessels both with freight and passengers for the whole of next year, and the trade once started, the advantages would be so apparent that the venture would undoubtedly be successful.

Success of the *Holland* Submarine Boat.—A series of exhaustive tests with the *Holland* submarine boat, which, it will be recollected, was declined by the British Admiralty, were made last month by the Board of Survey and Inspection of the United States Navy. The test was made in water 20 ft. deep. The run of one measured mile, submerged 10 ft. below the surface, was made in 9 minutes; the *Holland* then rose, discharged a Whitehead torpedo and disappeared in 10 seconds. The torpedo weighed 840 lbs., and was discharged from the bow tube, and at a range of 400 ft. it passed within 25 ft. of the target flag; the torpedo had no war-head, and travelled 800 ft. The *Holland* then turned under water in 1¼ times her own length of 54 ft. With decks awash and against a strong ebb tide she made 8 knots speed. The Board expressed itself, unofficially, as surprised and delighted with the success of the trial in all requirements. The *Holland* was built in 1896 at the Nixon shipyard, and cost about £60,000, but she could be duplicated for about half that sum. She is 54 ft. long, cylindrical in cross-section, and 9 ft. in diameter amidships. It is the sixth boat built by Mr. John P. Holland, and the present craft will be taken to Washington for further inspection.

MISCELLANEOUS.

British Trade in Rome.—Her Majesty's Consul at Rome suggests the establishment of a British Chamber of Commerce in Rome with a sample depôt attached. He points out there is a flourishing British Chamber of Commerce in Paris, and that there is no reason why there should not be one in Rome for the whole of Italy. The Consul states that the Chamber in Rome might be formed on much the same principles, and might gradually establish agencies in the larger towns of Italy, and provide them with samples of British goods. It would not be difficult to find some respectable British resident in every large Italian town disposed to take up the agency on commission, and to employ local commercial travellers to secure orders within each district. The question of decimal weights and measures for Italian customers is also a vital one, and the proposed Chamber might also prove of use in preparing for British exporters the necessary printed materials giving the decimal equivalents of English weights and measures. Complaints have come to his notice respecting the unreliable character of the information which some of the firms and enquiry offices in Italy supply to British traders respecting the position of tradesmen. A British Chamber of Commerce in Rome would put a remedy to all this by supplying reliable and genuine information. There are a great many firms in the United Kingdom interested in Italian trade, and they should, in their own interest, and in the interest of British Commerce generally, take up the matter.

A Consular Homily.—Her Majesty's Consul at Angola, in his report issued for the last two years —1897 and 1898—publishes some critical observations regarding British trading characteristics.

Despite warnings and suggestions from British officials, British trade shows an almost continuous decline, while German trade energy, relying on no Consular efforts (unless, perchance, British reports were studied in Germany), and demanding no information but such as it could obtain by its own trade dealings, has pushed its way ahead. The truth of the matter lies in the fact, so far as facts can be adduced from observation or general conclusions, that the individual German is a better trader than the individual Englishman. He may not make as good wares—although many think he does—but he knows better how to sell them. This statement is borne out by the customs returns of Loanda for the year 1898. During the first six months of the year the United Kingdom appears to have competed in 43 varieties of imports, Germany in 60. Where the British trader with unconcern waives aside a small market as a thing to be attended to later on when more worth his while, the German quietly sets about understanding the specially small needs of that market and the best way of meeting them; and in the end he will no doubt make it a bigger one, and the result profitable to himself. So, too, in satisfying his customers the German supplier will take more pains to be agreeable, and, strange as it may sound, he will more cheerfully adapt himself to and overcome certain difficulties before which the Englishman with his uncompromising humour will recoil. The foreigner, more politic, accommodates himself more readily to his surroundings in speech, manners, and deference to local custom. When it is realised that for the past 30 years duties upon British goods have probably contributed nine-tenths of the revenue upon which the province of Angola has been carried on, and that it was mainly by British shipping and the energy of British merchants in the past that this part of Africa was brought into commercial existence, British interest in the province should be readily roused. We notice the returns quoted by the Consul relative to the trade of Angola are for Great Britain and Germany 392,658,000 and 79,402,000 reis respectively. A milreis equals 4*s.* 2½*d.*

Openings for British Trade in Formosa.—An American Consul states, in a report lately issued, that although there is but little to be done in hardware in Formosa, yet a good opportunity exists for the introduction of American iron beds, not only in Formosa but throughout the East generally, providing the home manufacturers are willing to make the slight modifications required in producing an acceptable article. The American iron bed, enamelled in white and with brass trimmings, is superior in appearance to the English or continental beds found for sale in the East; and, although in every way equal in strength and firmness, it is manufactured in America at such a low cost that it can be placed on the Eastern market at about half the cost of the European article. The plague of insects is so prevalent in the East, and wood is so easily injured by the excessive damp, that wooden bedsteads find but little favour. The form of bed most suitable for use in tropical countries, differs from the present American model in two respects, *i.e.*, the body of the bed must be raised so as to be 2 ft. clear of the floor, and the four posts must be extended to a length of 7 ft. A mosquito net is used the year round in most tropical countries, and although an ingenious canopy arrangement, to be suspended from the ceiling, can be obtained in the United States, the only really satisfactory net is the one supported by the four bedposts, independent of outside fixtures. The four posts should be connected at the top by light rods bent at each end into a ring, which can be dropped over a pin which projects from the top of each post and which also affords a hold for the brass knobs which are to be placed on top. This frame forms a support for the mosquito net, which is either fastened to the rods with loops or is drawn over the whole frame. An English or continental double bed of this kind sells in the East for from 40 to 50 yen (£4 to £5).

The Utilisation of Peat in Ontario.—There are vast deposits of peat in Ontario which are submitted to a manufacturing process by which it is converted, as stated, into an excellent artificial fuel. The process is as follows:—The peat is cut and air dried, after which it is pulverized by being passed through a picker, and automatically deposited in a hopper which feeds a steel tube, about 2 in. in diameter and 15 in. long. The pulverized peat is forced through this tube by pressure, and formed into cylindrical blocks 3 in. in length and almost equal in density to anthracite coal. The fuel is nonfriable and weatherproof by reason of its solidity and the extreme glaze imparted to it by frictional contact with forming dies. The inherent moisture of the peat is reduced to 12 per cent. of the moss. In weight it compares with coal as follows: 83 pounds per cubic foot of peat equals 73 pounds of bituminous or 93 pounds of anthracite coal. It is claimed for peat that it is superior to coal in its absolute freedom from sulphur and the absence of smoke, soot, dust and clinkers during consumption, whilst its thermic value is as 100 pounds of heat to 95·15 pounds of coal.

Fire-Engines in Russia.—In the principal towns in Russia, says H.M.'s Consul, preference has hitherto been given to fire-engines manufactured by well-known British firms, but I am informed by the Chief of the Odessa Fire Brigade that Swedish engines have recently been imported here. These engines, which I am assured are quite 30 per cent. cheaper than those of either English or German make, gave satisfactory results at a recent review of the Odessa Fire Brigades, throwing a jet of water through a 1¾-in. nozzle to a height hitherto unattained by any engine in this city. The absence on the English engines of an appliance for preventing waste of water is considered to be a serious drawback. This is accomplished on other engines by the aid of a circulation pipe connecting the hose with the feed-pipe,

which causes a continuous flow of water from the ejecting hose back into the feed-pipe whenever work is suspended. The Odessa Brigade likewise possesses plant imported from Saxony.

Discovery of Asbestos in Ceylon.—Further information has now come to hand respecting the finds of asbestos and plumbago in Ceylon. The owners are Messrs. S. and P. Soy Sa and H. F. Fernando, who intend working the material at once. A sample has been submitted to expert examination and has been pronounced of excellent quality.

Hand *versus* Machine Labour.—Pursuant to a resolution of Congress, the United States Department of Labour has been investigating the effect of the displacement of hand labour by machinery in the iron and steel trades. From this report it has been found that files are now made with about one-third the hours of labour that were employed by hand workmen in 1872. A rifle-barrel took 98 hours' time of a hand workman in 1857, and it is now made with 3⅝ hours of labour. Half-inch bolts 6 in. long with nuts are made by hand at the rate of 500 in 43 hours, while by machinery the same product is turned out with only 8 hours' labour. In the manufacture of iron pipe, 100 ft. of 4-in. lap welded pipe cost 84½ hours of labour in 1835, while the same product was turned out with less than 5 hours' labour in 1895.

Some Properties of New Alloys. — In a recent paper, Mr. Bayley Marshall described some properties of the new alloys recently introduced in manufactures. At the outset the author pointed out instances of change in alloys due to external action and internal causes, and described a nickel-aluminium alloy, containing some 4 per cent. of nickel, which in a few hours after being cast fell to powder at ordinary temperatures—an extraordinary result when the toughness and malleability of the separate metals was regarded. The effect of bismuth on copper and brass was also referred to, and it was stated that, given the properties of a definite alloy, the effects of introducing even a trace of a foreign substance into it could not be foretold by any reasoning from analogy. The past masters of metallurgical art, the Japanese, had only reached their skill by generations of intelligent plodding, and often baffled us, with all our science, in the discovery of their methods. The author alluded to the application of metallic aluminium as a means of producing the rarer metals in a pure form, which process, he said, seemed likely to replace the more complex apparatus of the electric furnace; and then spoke of the steel that had recently been produced by melting hæmatite pig with steel scrap, and adding to the natural hardness of the mixture so obtained by a judicious addition of manganese-tungsten alloy, the solidity of the ingots being ensured by adding aluminium-nickel. The steel produced by that method did not lose its hardness by heating during use, and was said to be equal to that of ordinary "self-hardening" steel.

Elandslaagte as a Coal-mining Centre. —It is not generally known, says a contemporary, that Elandslaagte, where the British scored their first decided success over the Boers in the present campaign, is one of the leading centres of the Natal coal trade. There is a large colliery of that name, which under its previous management expended some £20,000 futilely in sinking its No. 3 shaft in the wrong place, but has since installed the "Jeffrey" type of mechanical coal-cutter, for which Messrs. John Davis & Son, Derby, are the English agents. This cutter was to be driven by electric motors. It is the first machine of its class introduced into Natal, and its utility has been proved—not only in replacing the untrustworthy, vagrant native labour, but in economising coal, by dispensing with holeing by hand. The "Waddle" fan, made by the Waddle Patent Fan and Engineering Company, Llanelly, has been adopted at the same colliery.

Iron Ore Decadence in Furness. — The hematite iron ore in Furness is stated to be rapidly declining, and, according to the figures quoted by Mr. Aslett, the general manager of the Furness Railways, the importation of Spanish ore is greatly on the increase. Rumours of new deposits having been found are constantly being brought to light, but although the Barrow Hematite Steel Company, the North Lonsdale Ironworks Company, and the Millom and Askam Companies—all very large concerns—continue boring operations, there is little room for congratulation. In 1880 the exported ore from Furness amounted to 200,000 tons, whereas last year it amounted to only 15,000 tons, and against this the foreign ore imported this year already exceeds 400,000 tons, in comparison with 250,000 throughout the 12 months last year. These figures speak for the necessity for the discovery of new beds of ore in Furness, or else the mining industry will decline to a great extent. On the other hand, since the foregoing was written, hematite iron ore has been reported from the Burlington pit of the Park Iron Mines, situated between Dalton and Ackam, and belonging to the Barrow Hematite Iron and Steel Company, Limited, Barrow. The Burlington pit has been the richest of the mines in the district, and a very deep shaft below the present workings has discovered a new bed of metal, which experienced men consider very valuable.

Melinite was originally picric acid, embedded in a collodion solution, and later on also fused picric acid. A mixture of fused picric acid and cresylic acid is now employed. Although picric acid was used as an explosive in the pulverulent state, mixed with saltpetre and other ingredients, yet the property of detonating with great violence when melted, was first indicated by Dr. Herman Sprengel, and afterwards patented by Eugéne Turpin, of Paris.

British Iron Exports to the United States.—Our contemporary the *Iron and Coal Trades Review* publishes the following sensible observations: "Only a few months ago the official organ of the American Iron and Steel Association spoke of the future of the iron trade as being entirely in the hands of the United States. It would be interesting to know what the writer of the article in question and those of similar articles that have appeared in American trade and daily newspapers think of the situation to-day, when the American people cannot furnish their own requirements and are compelled to come to Great Britain for a not inconsiderable part of their supplies, and when it is probably correct to assert that the conditions of prices in England are not, in any degree worth speaking of, affected by the course of prices there. Some of the American trade writers—including the editor of our excellent contemporary the *Iron Age*—seem disposed to minimise the present condition of affairs, and to ridicule the idea of any large body of orders coming over here. It can hardly be known to those who write thus that the United States have recently sent us considerable orders, not only for pig-iron and spiegeleisen, but for rails, billets, plates, and wire rods, and that one large establishment in Lancashire at this moment is almost entirely engaged on American contracts. It would probably be unreasonable and fallacious to expect that this condition of things will be of long continuance. We do not believe that it will last for many months. But, at least for the present, we may put away all anxiety as to 'the passing of the sceptre.'"

An Alleged Navigable Air-Ship.—A most extraordinary scheme is now being financially worked in Brooklyn, New York. It is proposed to build a navigable air-balloon 744 ft. long and 144 ft. in diameter, its ascensional power being derived from a vacuum produced in its interior. The theory is explained by the following details. The project is (quoting from the prospectus) to construct of steel a cylinder 744 ft. long and 144 ft. in diameter. This would hold, roughly estimated, 10,000,000 cubic ft. of air. A cubic foot of air weighs 0·0807 of a pound. By pumping out the air and creating a vacuum, 400 tons of weight would be disposed of. In other words, the displacement of the air-ship would be 400 tons. The air-ship, built of material strong enough to withstand the enormous pressure from the outside due to the vacuum within, would be 250 tons. The following data give the principal dimensions and weights: Diameter, ft. 144; displacement, volume, cubic ft., 10,000,000; displacement, weight, tons, 400; weight of steel for cylinder and cones, tons, 215; weight of car beneath, tons, 35; weight of electrical appliances, machinery, etc., tons, 33·4; weight of air remaining within cylinder as ballast, tons, 66·6. The air pumped out equals 333·4 tons, leaving an external pressure of 12·25 pounds per sq. in. The total weight of materials, machinery and air in reserve is 350 tons, which, deducted from the capacity of the cylinder, 400 tons, leaves an ascensional lifting power of 50 tons. The partial vacuum will allow an amount of 66·6 tons of air in reserve, to counteract atmospheric pressure of 2·4 pounds per sq. in. of area. Part of this ballast will be pumped out in the common reservoir if any extra load is to be carried, or for any emergency.

It is asserted that a capital of a million dollars has been raised for this absurd scheme, and that a Congressional committee has recommended a Governmental appropriation of a hundred and fifty thousand dollars to assist it.

A Badly wanted Invention.—A scourge which has long been experienced in India is now exercising the brains of inventors in the United States. The ravages of the white ant are stated to be quite as destructive in the Philippine Islands as in India, and the question of a wood that will resist their attacks is now being largely debated. It is stated that wood which will successfully resist these insect pests must be thoroughly charged with some powerful chemical, both poisonous and non-evaporable. A solution of corrosive sublimate, chloride of zinc, arsenic, or antimony would seem to meet the want. But how to force these into the fibres until the latter are saturated, and to do so at a merely fractional cost of the wood itself, is the problem that confronts the inventor. Up to the present, however, the problem has apparently been proved to be insoluble. A system of ant-proofing that would be both effective and economical would prove a public benefit, and a large source of income to the successful inventor.

A Note from a U.S. Consular Agent.—"Upon my endeavouring, the other day, to demonstrate the advantages of American tool-making machines to a local firm (Buxbaum Brothers)—one of the most important in this part of Bavaria—by means of a catalogue printed in English, I was told that the firm had no time for translations. At the same time, the manager showed me the catalogue of an American manufacturer of agricultural machinery, beautifully prepared, translated into German, brief and to the point; the machines (reapers and mowers) of the firm are to be found in this part of the country by the score. He said: 'Our agents always carry these catalogues with them, and they can be found among the best classes of the peasantry'"—*verb. sap.*

The Growing Consumption of Tin.—The consumption of tin for the last two years is shewn in the appended table:—

	1897. Tons.	1898. Tons.
United States ...	25,000	29,000
Great Britain ...	15,000	13,000
Germany	12,500	14,500
France	7,000	8,500
Rest of Europe ...	8,000	10,000
Australia	3,000	3,000
Asia	5,000	5,000

Growth of the British Cotton Trade.—It was stated at a recent meeting of the Manchester Chamber of Commerce, that the cotton trade of this country was sharing in a prosperity such as few of the members had ever known. It was stated that the increase of the textile exports in the last nine months was chiefly in the Indian departments, and, though the exports to India were not so large as at some former periods, they showed that Lancashire held its own in the competition due to the laying down of new machinery abroad. Home consumption showed a gratifying growth. The proportion of cotton goods used in England in relation to the vast figure of the exports was formerly very small, but last year it was about one-fifth, and it had been gradually increasing.

Liquid Oil for Fuel in Russia.—The output of liquid fuel, or masut, and of petroleum by-products has now become the mainstay of the petroleum industry in Russia. The annual quantity of masut consumed amounts to no less than 500,000,000 poods, which, with the extension of the railways, is expected to further increase to a large extent. Not only in the firing of locomotive boilers liquid fuel is playing an important part, but also in connection with the raising of steam in marine boilers. As a preliminary all the war vessels belonging to the Baltic fleet are now fired with liquid fuel, and, it is believed, the whole of the Russian Imperial Navy will eventually be converted to the system, according to a gradual process of transformation. The industry is at present hampered through lack of a sufficient number of tank steamers.

Bacteria as Destroyers of Masonry.—In a recent issue of the *Lancet* the work of bacteria as an industrial agent is discussed, more especially in connection with the sewage question. A somewhat new aspect of these agents is, however, disclosed in their action upon masonry. At first sight it would seem hardly possible for bacteria to be concerned in the breaking down a stone wall, yet such would appear to be the case, according to some ingenious observations directed to the nature of the decay of cement. The gradual disintegration of the cement mortar used in water supply reservoirs is one of the serious troubles met with by water engineers, and a trouble which so far they have not been able to avoid with any measure of practical success. Hitherto this action was supposed to be the result of the solvent property of carbonic acid and other mineral substances commonly present in a water supply. The cement gradually disintegrates and becomes a kind of mud, which slowly detaches itself. This strange process is due to the action of none other than that bacterium known as the nitrifying organism. An examination of the mud shows it to be teeming with these organisms. The organism, however, cannot flourish in the absence of nitrifiable pabulum. In its presence, however, nitrous acid is produced, which leads most probably to the disintegration of the cement lining of the water reservoir. The nitrifying organism is the one upon which so much depends in the purification of sewage and effete matters. On this account its growth should be encouraged, and it is curious, therefore, to find that the organism appears as an objectionable factor in the attempt to supply and store an abundance of pure water for drinking purposes.

The Canadian Lead Industry and the KcKinley Tariff. — The provision in the McKinley tariff whereby lead ores can be smelted in the United States in bond is an excellent one for American smelter interests, which can import lead ores, refine them, and sell the metal abroad without paying the duty of 1½ cents per pound. But the granting of this privilege makes it exceedingly difficult for a Canadian smelter to do business profitably. The customs duty of 2½ cents per pound on pig lead cuts them off completely from the American market. The arrangement for smelting in bond exposes Canadians to the competition of the product of their own ores if they seek to gain a footing in the foreign market, and their own market is denied to them because the Canadian miner, after having his ore smelted and refined in the United States, cannot profitably receive it back over the border again, for it is then subject to the Canadian duty of 15 per cent. It has been pointed out that the duty on lead coming from England, 25 per cent. less than if it came from the United States, is also against Canada. The lead extracted from Canadian ores in the United States is sent to England, where it has free entry, and then is returned to Canada and entered at the reduced rate accorded to all British commodities, making the duty 11¼ per cent. instead of the 15 per cent. to which Canadian lead is subject when returned from the American smelter.

An Artificial Cork.—Phellosene is the name given by a French inventor to a substance he describes as artificial cork, and which may be used for all purposes for which cork has hitherto been found needful. It is an analogue of celluloid, and consists of cork bark ground to an impalpable powder and agglutinated by a solution of nitro-cellulose in acetone. This material is made into a doughy mass, compressed into moulds and dried. It contains about 10 to 12 per cent. of nitro-cellulose, and is said to be a trifle, if anything, more combustible than cork under the ordinary conditions.

Artificial Cotton.—The United States Consul at Reichenburg quotes an account in a local newspaper of a process for making artificial cotton from the wood of the fir-tree. It appears that the wood is reduced to thin shavings, which are placed in a washing apparatus, exposed to the influence of steam for ten hours. They are then subjected to a strong preparation of sodium lye, and are heated under great pressure for thirty-six hours. The wood is now changed to pure cellulose, and to

give this a greater resisting power, some castor oil, caffeine, and gelatine are added. The substance is then put into an apparatus and made into threads, which are reeled. The article concludes:—"Artificial cotton can be produced so cheaply that the genuine article can hardly compete with it, and one cannot say that it is sham, for it is composed, exactly as the natural cotton, of pure cellulose." The Consul adds that in a country such as Germany, where all the cotton used in the numerous factories must be brought from far India and the United States, such a device should be profitable.

To Encourage Employees.—A large manufacturing house, according to the *Age of Steel*, presented a long list of prizes to such of its employees as had made useful suggestions for the improvement of machines or processes that were under their management. During the last half of the year 1898 eight hundred suggestions had been put on record, out of which about two hundred had been adopted and put into practice.

The Mineral Production of the United Kingdom for 1898.—A Board of Trade report states that the value of all minerals raised in the United Kingdom last year exceeded £77,000,000, an increase of £5,000,000 on 1897. This increase is chiefly attributable to the higher prices for coal, which, of course, is by far the largest single item in the list of minerals produced. The principal mining counties of the kingdom, whether judged by the mineral produced or number of persons employed, are: Durham, with an output of 34,737,347 tons of coal; Yorkshire, with 25,629,021 tons of coal and 8,785,588 tons of iron ore; Lancashire, with 24,324,685 tons of coal and 749,427 tons of iron ore; and Glamorganshire, which yielded no less than 19,140,742 tons of coal, in spite of a strike lasting five months. Cornwall, with its historic tin mines, pales into insignificance when compared with the four great coal counties, in which is concentrated nearly one-half of the mineral industry of the kingdom. Even if the United Kingdom produced no other mineral than coal, it would be a great mining country. The output for 1898, though slightly less than in the previous year, still exceeded 202,000,000 tons; indeed, had it not been for the strike, which caused a deficiency of more than 9,000,000 ons from the South Wales coalfield, it is evident that the rise in the output, which had been going on since 1893, would have continued steadily. Our export of coal was about half a million tons less than in 1897; the total quantity was 36½ million tons. It is satisfactory in the case of iron ore to find that British mines and quarries are increasing their supplies, though their total output is still nearly 4,000,000 tons below the high-water figures of 1880 and 1882. In the case of the ores of copper, tin, and zinc, higher prices for the metal have had the natural effect of increasing the output; but even this stimulus has been insufficient to prevent the continuous fall in the production of lead ore.

The Industrial Future of Liquid Air.—Some experiments made recently by Professor von Lang with liquid air have excited great interest. The liquid air experimented with was stored in an open receptacle with double walls, the rim of which was covered with ice in consequence of the difference in temperature. The double walls form a space free of air as an effective guard against drawing on heat from outside to enable the air being kept liquid for a lengthened period. The experiments were begun by filtering the liquid air first, and then the Professor proved, by immersing a burning chip of wood, which burnt with a vivid flame, the prevalence of a considerable amount of oxygen. This is explained by the nitrogen evaporating quicker than the oxygen, which is found in liquid air to form 35 to 40 per cent., while in the atmosphere it only forms 21 per cent. of the air. Poured into a basin of water pieces of ice of exceptional cold are formed. If these pieces are picked up by hand, or if the hand is only for a second dipped into liquid air, a sore is caused similar to that of a burn. If an indiarubber tube is immersed in a receptacle with liquid air, it becomes at once as hard as stone, while flowers that were immersed got instantly so hard as to require a hammer to break them to pieces. Quicksilver fumes settled like a mirror on the inner wall of the tube when treated with liquid air. The further experiments demonstrated the freezing, *i.e.*, liquefaction of pure alcohol, carbonic acid gas and acetylene gas, by conducting these through a tube into small glasses filled with liquid air. Acetylene snow burned with a beautiful yellow flame. A lead saucer containing liquid air, when struck with a hammer, produced a clear, melodious sound like that of a bell. The explosive powers of liquid air were demonstrated by igniting cotton-wool and powdered charcoal saturated with liquid air, which flared up with great suddenness.

Basic Slag as a Fertilising Agent.—It is only a few years since the value of basic slag—one of the by-products of the blast furnace—as a fertiliser came to be recognized. Sir Alfred Hickman, M.P., was among the first ironmasters in South Staffordshire to introduce the material to agriculturists, and to impress upon them the large percentage of phosphorus which the by-product contained, and its great value in consequence as a fertiliser of the land. Agricultural lecturers of the Staffordshire County Council recommended farmers to try the experiment, but they were as a rule slow to act upon the advice. At length the use of basic slag was tried, and its success was so complete that it soon acquired a market value of 10*s.* per ton. The price to-day is 35*s.* per ton, and there is every indication that its value will continue to appreciate, as the supply is limited and the demand is steadily increasing.

Lathe Chucks and Substitute for Them.—It is a fact familiar to those who have observed the use of lathes in Continental shops that the workmen there make use of removable jaws

similar to our chuck jaws, which jaws are attached to the large face plate of the lathe. In some cases these are very crude affairs, being mere studs with set-screws in them, but in others they are better made, and have a block which clamps to the face plate and a sliding jaw attached to this block, which jaw is adjusted by a screw. Many lathe makers have been obliged to furnish some such jaw for use on the plate, and to meet this demand an American Company is making a face plate with jaws, which face plate is threaded and attached to the lathe spindle in the ordinary way. While this is probably all right for the Continental lathesman, it occurs to the *American Machinist* that it would be far preferable to leave the jaws attached to this plate and take it off from the spindle and substitute a plain plate whenever required ; the unscrewing of one plate from the spindle and putting on another one being obviously a much quicker and more convenient operation than removing or attaching four sliding jaws to a plate already on the spindle, unless the lathe is a large one. This, of course, reduces to the use of our regular lathe chucks, and that is what we think should be used ; but much educational work remains to be done, apparently, before they will be generally used in Continental shops.

Compressed Peat Fuel.—Compressed peat fuel is now being made by the Canadian Peat Fuel Company, of Stratford, Ontario. The peat area is 40,000 acres, and from 1 to 20 feet thick. The material is cut and air-dried; it is then pulverised, passed through a picker to a hopper, which automatically feeds into a 2-inch steel tube, 15 inches long. The pulverised peat is forced through this tube by pressure and formed by dies into cylinders three inches long, and almost as dense as anthracite coal. The fuel, it is stated, does not break up, and is weather-proof, owing to the glaze given it by frictional contact with the dies. It weighs 83 lbs. per cubic foot, as compared with 73 lbs. for bituminous coal, and 93 lbs. for anthracite. It has been tested in locomotives, showing a thermal value of 100 lbs. of peat, equal to 93·15 lbs. of coal. Tried in the power house of the Metropolitan Street Railway of Toronto, it was found that the heat produced was much greater than that of coal, but it was 8 per cent. deficient in lasting power. The cost of manufacture is stated to be 60 cents per ton under the best conditions.

Moorish Industry at the Glasgow Exhibition.—It is stated that the arrangements for the representation of Fez industries at the Glasgow Exhibition of 1901 are almost completed. The Sultan, it is understood, will finance the undertaking to the amount of 30,000 dols. Six of the merchants of Fez have been appointed to superintend the arrangements, and they will accompany the deputation, their expenses being paid for them; 22,000 dols. of the total sum advanced will be spent on the purchase of the exhibits, &c., while the remaining 8,000 dols. are to defray the cost of installation in a building which is to be in the Moorish style of architecture. The builders, tile-cutters, and others are said to have already left Fez. It is probable that the towns of Rabat and Tetuan will likewise be represented at this Exhibition.

Another French Submarine.—The launch of the new submarine torpedo-boat *Narval* took place at Cherbourg last month. The length of the vessel is 110 ft., and the breadth 12 ft. 6 in., and she has a displacement of 106 tons. The hull is composed of two skins, separated from each other by water-tight bulkheads. When operating on the surface the vessel is driven by ordinary steam engines of 250 h.-p. As soon as she dives the motive power is supplied by dynamos, the electricity being derived from accumulators previously charged by the steam engines. The expectation is that on the surface the *Narval* will run 252 knots at 12 knots. Under water her maximum speed is 8 knots, and she can only keep it up for three hours. The armament, all carried on the upper deck, consists of four torpedo tubes.

The Utilisation of Blast Furnace Slag.—It is evidently not the fault of inventors if blast furnace slag is not more largely used. As it is, the scope of its utility ranges from textile to break-water construction. Attempts have recently been made to utilise blast furnace slag by converting it direct into building stone. The efforts which have been made in this direction have not hitherto met with success, owing to the presence of calcium sulphide in the slag. If the sulphur could be removed the material, it is thought, would make splendid building stone for the facing of walls, capable of being tooled, as tough as granite, and more homogeneous than basalt.

New Industrial Opening in Spain.—It is mentioned in a report by Her Majesty's Consul at Barcelona that the manufacture of linoleum and similar articles might possibly be carried on with advantage by a British firm putting up a factory in Catalonia, in the same way as English manufacturers have done in some other classes of manufacture in Spain. The principal materials required are, it is said, cork shavings and jute waste, both of which are to be obtained in the neighbourhood. The cork shavings from the numerous factories in the department of Gerona are now shipped in pressed bales from the small ports of Salamos and San Feliu de Guixols (distant about 50 miles from Barcelona) to Kirkcaldy Roads for consumption in the linoleum mills in that district. The freight, about 25*s.* per ton, would be saved if the manufacture were carried on in Barcelona, and labour could be obtained certainly at a cheaper rate than in Great Britain.

Trade Conditions in Mexico.—Mexican merchants, it is stated, are noted for their integrity. A United States Consular Report upon commerce and industries in Mexico, says: "There are very

few concerns here doing business that have not ample capital to carry out all contracts into which they may enter. Failures are very rare indeed, and when they do occur are carefully investigated by the authorities in the interest of creditors, and any attempts to defraud are severely punished. Book entries are regarded as sacred. All books kept by business houses are known and small stamp taxes paid on them, and thus a sort of surveillance is kept over them by the Government authorities."

Laying Cable by Locomotive.—A Locomotive Cable-layer, states the *Engineering News*, was employed in relaying a telegraph cable. The distance was 600 ft., and the new cable weighed about 3 tons. The method pursued was as follows: The cable was stretched across the line of the crossing and 1,000 ft. of 1½-in. rope was attached to it and led to a powerful freight locomotive, stationed on the track, and this rope was passed over a snatch-block placed on the line. When all was ready the locomotive moved off and the cable was pulled across in 11 mins. 33 secs., though the strain on the rope was considerable as the cable pushed through a muddy river bed.

The Trade Future of Nicaragua.—Nicaragua is rich in mineral as well as agricultural resources. The gold mines are numerous and the precious metal is mined with large profits. Copper and opal are also plentiful, though Honduras, the neighbourhood on the north, is especially noted for her fine opals. The agricultural products include coffee, corn, beans, wheat, rice, sugar, cotton, tobacco, and garden vegetables, while tropical fruits are everywhere abundant. The quality of tobacco is fine and in some zones rivals that of Havana. The forests are dense with fine hard wood, which is quite an item of export, and they supply the United States with a very great per centage of her mahogany. The fertile plains are also suitable for stock raising, and cattle are marketed extensively in Central America, and at this time are being shipped by thousands to Cuba.

An American View of Gas Engines.—A prominent United States manufacturer is reported as making the following statements:—"In Great Britain the coal oil engine has been in use for some years. We are now studying the problem ourselves, and indications warrant the statement that American prices will be considerably lower. As a rule American patterns of gas and gasoline engines have a superior governing system. They are simpler and more compact, and much cheaper than those of other countries. Our most serious rivals are the Germans, but they do not begin to compete with us in price. We manufacture on a larger scale, turning out, by the duplicate part system, lots of a hundred engines 2½ h.p. each at one time. The foreign sales of our engines during the last year have multiplied by four. Two carloads comprising 60 engines of varying horse power were shipped to Japan recently. Several high-speed engines have been shipped to Porto Rico. Thirty gas and gasoline engines were yesterday shipped to Tokio for driving printing presses, and carload lots have within a few weeks been sent to Australia, Germany and France."

Acetylene Gas Supply Works in Operation.—It is stated that on the Continent there are 31 Acetylene Supply Works in operation supplying communities of from 23,809 down to 1,111. In the United States there are five, the biggest at Wabash, installed in a community of 12,500. In England there are three at most, and comparatively insignificant. The cost to the consumer per 1,000 ft. appears to work out about £3 5*s.*, which seems low on the whole.

A Threatened Zinc Trust.—Reports, said to be well founded, are current in Paris of a project for combining together the principal producers of zinc in various countries. Germany is the chief source of this metal, its production being about 140,000 tons per annum. Belgium yields about 110,000 tons, and the United States about 100,000 tons. Zinc ore is also obtained, in much smaller proportions, in Holland, Italy, Spain, Australia, and Tunis. From Tunis the supplies have been considerably increasing within the last two years. The entire production of the metal throughout the world is estimated to be 460,000 tons, of which 350,000 tons are contributed by Germany, Belgium, and the United States. The movement in favour of combination is understood to proceed, or at least to be most earnestly promoted, in Germany, where already some sort of agreement exists amongst the producers of zinc.

Trade Import Remissions in Russia.—We take from a British Consular Report the following details respecting certain important fiscal changes in Russia. The Consul states:—During the year 1898 several important measures were passed into law bearing largely upon the fiscal condition of Russia, and all more or less worthy of the attention of British manufacturers and exporters. The most important of these were: (1) The remission of the import duty upon foreign-built iron vessels destined for foreign sea trade, and parts thereof, which came into operation on July 13th last, and remains in force for ten years from that date. (2) The remission of import duties upon self-binders, self-delivery reapers, horse rakes, steam ploughs, combined clover threshers with two drums, steam threshers with drums not less than 54 in. wide, or with peg drums not less than 40 in. wide, &c. Specified duplicate parts, mostly required for repairs of the above machines, are also admitted free when accompanying the respective machines. Portable engines accompanying steam ploughs or steam threshers now pay 75 *c.* per pood (4*s.* 8*d.* per cwt.), as against 2 *r.* 10 *c.* per pood (13*s.* per cwt.) levied formerly, which is still payable when the engines are imported without steam threshers or ploughs. The duty upon duplicate parts for reaping machinery,

ploughs, &c., accompanying the machines to which they belong, has been reduced from 2 *r.* 10 *c.* per pood (13*s.* per cwt.) to 75 *c.* per pood (4*s.* 8*d.* per cwt.). Artificial manures, &c., will now be admitted free of duty. This law came into operation on September 13th last year, and is to remain in force until December, 1903. (3) The admission, duty free, of all foreign-made machinery for the gold-mining industries of Siberia and the Urals. (4) The admission, duty free, of most articles imported through the northern rivers, the Obi and Jenisei.

Gas Bye-Products in Manchester.—The Manchester Corporation propose to work up their own gas residuals. It is stated that the arrangements are such that, in the conversion of the gas liquor into sulphate of ammonia, the risk of nuisance would be less than in other works of this class, because, as the production of sulphuric acid would be ancillary to the other, the sulphuretted hydrogen gas produced in the sulphate manufacture would be utilised in the oil of vitriol plant. In this way the process would not only be an economical one, but a much needed object lesson would be given by the Gas Committee in the conduct of a manufacture in connection with which complaints not infrequently arose. The works, when carried out by a competent contractor, will, it is said, be a model works of its kind. With all the best modern appliances and arrangements for conducting the operations with economy and success, considerable saving of labour in handling the materials, both raw and finished, would be effected by the large use of automatic machinery. The sulphate of ammonia plant, as designed, was of a capacity sufficient to produce 20 tons per day of 24 hours. The sulphuric acid plant would be capable of turning out about 78 tons of acid per week. The following is the summary of the estimate: Sulphate plant, £9,480; acid plant, £9,330; connections and valves to sulphate plant, boilers, and acid plant (including liquor plant), £2,500; boiler-house (with chimney), £1,200; foundations for sulphate and acid plants (including sumps and drains), £2,000; contingencies, £490—total, £25,000.

Coal in Japan.—The United States has just issued an interesting report on the coal supply of Japan, in which it is stated that this, the most important mineral of the country, is found in the northernmost island, Hokkaido, and in the northern part of the island of Hondo; and in large quantities in the most southerly island of the group, Kiushiu. Coal has been mined systematically during the past 30 years, formerly by the Government, but more recently the management has been transferred to a prominent financial firm of private citizens, who promptly established trading stations, not only in Japan, but also in China, Straits Settlements, Burmah, and the Philippine Islands. Their products rapidly took the place of Australian coal, upon which steamships in that part of the world were formerly compelled largely to rely. Branch railways convey the coal to ports 50 miles distant, where steamships can have constant access to the docks and depôts of supply. The coal veins at the most important of these mines range from 8 ft. to 20 ft. in thickness. The exports of coal from Japan have been steadily growing. In 1893 they had a value of 3,288,843 yen (£328,884 at 2*s.* per yen), whereas for 1897 they had increased to 8,316,776 yen (£831,677). In Tokyo, in 1897, coal was selling at retail at 9·16 yen per ton (2,000 lbs.), or slightly over 18*s.* The total amount of coal mined in Japan increased from 3,168,875 tons in 1891 to 5,019,689 tons in 1896.

An Amalgamation.—We are advised of the amalgamation of Messrs. W. Pope and Son, Ltd., of Gotha Iron Works, Slough, the Coil Clutch and Pulley Co., Ltd., of Gotha Iron Works, Slough, and the Patent Deep Stamping Co., Metropolitan Works, Bermondsey, London. The title of the amalgamation will be the Consolidated Engineering Co., Ltd.; Mr. W. M. McLaren, of the Patent Deep Stamping Co., becoming Chairman of the new Company.

The Granville Automatic Typewriter.—It has been pointed out to us by Mr. Gordon Cressy, of the Granville Automatic Typewriter Syndicate, Ltd., that the notice of this machine which appeared in a recent issue of FEILDEN'S MAGAZINE is liable to give rise to a false impression concerning one point of this excellent typewriter. The paragraph referred to questioned the claim made by the typewriter as being automatic in action. On an examination of the typewriter, we find this claim to be fully established; that is, the feeding of the paper takes place automatically, requiring no hand action whatever. The machine is controlled entirely from the key-board, and the Syndicate, we think, apart from the other undeniable merits of mechanism, are entitled to claim this action as a most valuable feature. That there is a future before the Granville Automatic Typewriter in this country there can be no doubt.

The Editor of FEILDEN'S MAGAZINE

Will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

Heads of Departments

Foremen, Under-foremen, and Skilled Mechanics, are invited to communicate practical suggestions and drawings for insertion in the "Workshop Practice" section.

ARCHITECTURE AND BUILDING.

1. Construction and Design.

Arch Construction.—*The Three-Hinged Arch.* The article tries to demonstrate that though from a purely theoretical standpoint the three-hinged arch possesses unquestionably, for its own particular type or principle of construction, superior claims to attention over the two-hinged, the hingeless or fixed-at-the-end examples, from a practical point of view and submitted to actual experience it becomes, in some respects, inferior to the other types. 1½ cols.—*Engr.*, Dec. 1st, No. 2292.

Lodging-Houses.—*Rowton House, Hammersmith Road, W.* Description of the fourth of the series of "Poor Men's Hotels" known as "Rowton Houses." 1¾ cols.—*Builder*, Dec. 9th, 1899, No. 2966.

Materials.—*Testing of Materials of Construction* (continued). 3¾ cols.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

University.—*Designs for a Model University.* A retrospective Review of the California University Competition. A critical discussion of some of the plans submitted, and high appreciation of M. Bénard's premiated design. (Ill.). 7 cols.—*Builder*, Dec. 9th, 1899, No. 2966.

2. Heating and Ventilation.

3. Plumbing and Gasfitting.

4. Miscellaneous.

Aims of Architecture.—*Scottish Architectural Matters looked at from the outside.* An address delivered to the Edinburgh Architectural Association. Nov. 29th, by Mr. James Bruce, President. —*Builder*, Dec. 9th, 1899, No. 2966.

CIVIL ENGINEERING.

1. Bridges.

Bridges.—*Bridge Design.* Comments on a paper by Mr. E. H. Stone, Chief Engineer to the East Indian Railway Company, Calcutta, read before the American Society of Civil Engineers. 2½ cols. —*Engng.*, Nov. 17th, 1899, No. 1768.

Bridge Building.—*The Cables and Suspenders for the New East River Bridge, New York City.* (Ill.). 3½ cols.—*Engng. News* (New York), Nov. 23rd, 1899, Vol. XLII., No. 21.

Draw Bridge.—*Experimental Determination of Draw-Bridge Reactions.* By Malud A. Howe, M. Am. Soc. E., Professor of Engineering, Rose Polytechnic Institute at Terre Haute, Ind., U.S.A. (Ill.). 4½ cols.—*Engng. News* (New York), Nov. 30th, 1899, Vol. XLII., No. 22.

Railway Bridge.—*The Temporary Restoration of Railway Bridges.* (Ill.). 5 cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

2. Canals, Rivers and Harbours.

Canals.—*Locks and Lock-Gates for Ship Canals.* Abstract of a paper by Mr. Henry Goldmark, M. Am. Soc. C.E., in the Transactions of the Association of Civil Engineers of Cornell University for May, 1899. 3 cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Dam.—*Regulating the Waterlevels of the Great Lakes by a Dam on the Niagara River.* Abstract of an address by Mr. Geo. Y. Wisner, M. Am. Soc. C.E., of Detroit, Mich., delivered before the Cleveland Chamber of Commerce, Oct. 17th, 1899. 3¾ cols.—*Engng. News* (New York), Nov. 23rd, 1899, Vol. XLII., No. 21.

Dredger.—*Hydraulic Dredger (Bates System) for the Russian Government.* (Ill.). ½ col.—*Engng.*, Dec. 1st, 1899, No. 1770.

German Canal.—*The Dortmund-Ems-Canal.* Description of the canal and its working. (Ill.). 2 cols.—*Engr.*, Nov. 17th, 1899, No. 2290.

Waterways.—*The Waterways of Russia.* By C. H. Moberly, M. Inst. C.E., M.I. Mech. E. (continued). 3¼ cols.—*Engng.*, Nov. 17th, 1899, No. 1768.

3. Irrigation.

Reservoirs.—*Surveys of Sites for Irrigation Storage Reservoirs, by the U.S. Geological Survey.* Abstract of a report relating to the subject of water-storage prepared by Mr. P. H. Newell, hydrographer in charge of the survey which was approved on Nov. 11th, by the U.S. Secretary of Interior. 1¾ col.—*Engng. News* (New York), Nov. 23rd, 1899, Vol. XLII., No. 21.

4. Miscellaneous.

Catch-Water-Lade Needed.—*The Recent Disaster in Darjeeling* (Ill.) Description of the Landslide that occurred Sept. 27th this year. 1 col. —*Engr.*, Dec. 1st, No. 2292.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Bleaching.—*Electrical Bleaching.* V. Engelhardt. The paper refers to the results obtained in the bleach works of F. Gebauer, at Charlottenburg, on a large scale with a Kellner electrolytic cell attached to a tank, maintained at 20 to 25 deg. C., and provided with a centrifugal pump and pipes of hard lead.—*Elektrochem. Ztschr.*, pp. 27—29, 1899. Sc. Abs., Dec., 1899.

Industrial Progress.—*Position of Industrial Electro-Chemistry.* This paper contains a statement of the power utilized and available at every electro-chemical or metallurgical works now in existence, together with the names of the owners, and the engineers who supplied the plant and

machinery. The record, however, is incomplete.—*Zeitschr. Elektrochem.*, pp. 61—80, July, 1899. Sc. Abs., Dec., 1899.

Saturation of Solutions.—*Electrical Determination of Saturation-Point of Solutions.* J. H. van't Hoff. Abstract of a paper describing a method based upon the experiments of Dawson and Chiacaviglio for determining the saturation-point of solutions of two or more salts by measuring the electrical resistance of the solution.—*Zeitschr. Elektrochem.*, pp. 57—61, July, 1899. Sc. Abs., Dec., 1899.

Voltaic Cells.—*Some Experiments on Voltaic Cells with Compound Electrodes.* By Frederick S. Spiers, B.Sc. (to be continued). 2¼ cols.—*Elec. Rev.*, Dec. 8th, 1899, No. 1,150.

2. Electric Lighting.

Carbon Making.—*Carbon Making.* 1½ cols. (Ill.).—*Elec. Rev.* (New York), Nov. 29th, 1899, Vol. XXXV., No. 22.

Electric Plants.—*Electric Plants of the Battleships "Kearsarge" and "Kentucky."* Summary of a paper read before the Society of Naval Architects and Marine Engineers, New York, Nov. 16th, 1899. (Ill.). 11½ cols. (continued).—*Elec. Rev.* (New York), Nov. 29th, 1899, Vol. XXXV., No. 22.

Cost of Central Station Plant. 2 cols. (to be continued).—*Elec. Rev.*, Nov. 17th, 1899, No. 1,147.

Filaments. — *Long Filaments in Incandescent Lamps, The advantages of.* 2¾ cols.—*Elec. Rev.*, Dec. 8th, 1899, No. 1,150.

Incandescent Light.—*The R. H. S. Anti-Vibrator for Incandescent Light.* Description of an anti-vibrator invented by Prof. R. H. Smith. (Ill.). 1 col.—*Journal of Gas Lighting*, Nov. 28th, 1899, No. 1,907.

Lighting Installation.—*Electric Lighting.* Allegheny County Light Company. (Ill.). 3¼ cols.—*Engng.*, Nov. 10th, 1899.

Brooklyn's Modern Electric Light Station.—Description of the installation of the King's County Electric Light and Power Company in Brooklyn, N.Y., U.S.A. (Ill.). 8¼ cols.—*Elec. Rev.* (New York), Nov. 22nd, 1899, Vol. XXXV., No. 21.

The Electric Lighting at Windsor.—Description of the installation by the Windsor and Eton Electrical Installation Company. (Ill.). 3 cols.—*Elec. Engr.*, Dec. 8th, 1899. New Series, Vol. XXIV., No. 93.

Electric Plants of the Battleships "Kearsarge" and "Kentucky".—Summary of a paper read before the Society of Naval Architects and Marine Engineers, New York, Nov. 16th, 1899. (Ill.). 6 cols. (To be continued).—*Elec. Rev.* (New York), Nov. 22nd, 1899, Vol. XXXV., No. 21.

Greenock Electricity Works. 1¼ cols.—*Elec. Engr.*, Dec. 8th, 1899. New Series, Vol. XXIV., No. 93.

Lighting Projects.—*Electric and Gas Schemes* in Parliament. 3¼ cols.—*Engng.*, Dec. 8th, 1899, No. 1771.

3. Power.

Accumulators.—*The Sherrin Accumulator.* Description of accumulators manufactured by Messrs. W. Pope and Sons, of Slough. (Ill.). 1¼ col.—*Elec. Engr.*, Dec. 8th, 1899. New Series, Vol. XXIV., No. 93.

Drilling Machine.—*Portable Electric Drilling Machine.* Description of a drill driven by an electric motor with a 30 per cent. speed regulation, manufactured by the Stow Company, of Binghampton, N.Y.—*Electr. World and Engr.*, p. 105, July, 1899. Sc. Abs., Dec., 1899.

Dynamos. — *Automatic Pressure Regulator.* Account of the "Chapman" Regulator for automatically varying the resistance in the shunt circuit of dynamos. (Ill.).—*Electrician*, Aug. 11th, 1899. Sc. Abs., Dec., 1899.

Dynamos.—200 *I. H. P. Combined Engine and Dynamo.* Description of machinery constructed by Messrs. Mather and Platt, Ltd., of Salford Ironworks, Manchester, for lighting, traction, power transmission, electrolytic and other purposes. (Ill.). 1 col.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Dynamos.—*Over-Compounding Dynamos.* E. K. Scott. The author outlines a method of compensating for the curvature of the B.-H. curve by shunting the series coils with iron wire. It is pointed out that over-compounding, by increasing the magnetic flux, ends in reducing sparking at the brushes.—*Electr. Rev.*, pp. 428-429, Sept., 1899. Sc. Abs., Dec., 1899.

Dynamos.—*A New Type of Direct-Current Dynamos.* Description of a new type of Lundell generators manufactured by the Sprague Electric Company of New York, and said to run with no perceptible sparking and to regulate admirably under difficult conditions of use. (Ill.). 1½ cols.—*Elec. Rev.* (New York), Nov. 1st, 1899, Vol. XXXV., No. 18.

Electric Aid to Gas Manufacture.—*Electric Power Machinery.* Discussion of the question of applying electrical power distribution to the various mechanical operations of gas manufacture. 2 cols.—*Journal of Gas Lighting*, Nov. 21st, 1899, No. 1906.

Electric Driving.—*An Interesting Application of Electric Driving.* Description of an installation showing the application of "direct electrical driving to machine tools," permitting of a varied and extensive use of portable tools which may be easily carried on a small trolley, and heavy, which require the services of a good travelling crane to transport them. ½ col.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Electric and Oil Motor Car.—*Combined Electric and Petrol Motor Car.*—E. Hospitalier. Account of a car constructed by the Pieper Company which is ordinarily impelled by an oil engine, but on difficult ground is helped by an electric motor. The oil engine works at a constant rate, and when the vehicle does not require all the engine's power the excess drives the motor as a dynamo and charges the accumulators. The engine is direct coupled to the dynamo-motor which is shunt wound, and is also used to start the engine.—*Ind. Elect.*, pp. 316-319, July 25, 1899. Sc. Abs., Dec. 1899.

Electric Motors.—*Automatic Current Motors.* By Alton D. Adams (continued). 2¾ cols.—*Engr.* (New York), Nov. 1st, 1899, No. 490.

Electric Plant.—*Electric Power in a Ship Yard.*—Article describing the plant in the works of the Chicago Shipbuilding Company. (Ill.) 3 cols.—*Elec. Rev.*, Nov. 10th, 1899, No. 1146.

Burnley Electricity Works (continued.) 1½ cols. (Ill.)—*Electrical Engr.*, Dec. 8th, 1899, New Series, Vol. XXIV., No. 93.

Electricity Works of Small Output. A. D. Adams.—The author deals with the problem of electric installations in comparatively small towns, and compares the direct and alternating currents for that purpose.—*Amer. Electn.*, June, 1899, pp. 263-64. Sc. Abs., Dec. 1899.

Electric Power in Coal-Mines.—*Electric Transmission of Force in Coal-Mines.* By Arthur Bloemendal, Engineer of the "Verein. Elektr. Ges." in Vienna. In this paper the author points out that, as experience has shown, electrical machinery, as far as reliability goes, is at least equal to machinery driven by steam, while it is preferable in so far as it permits simplification of the service and great centralisation, and thus secures great effectiveness. 12½ cols. (Ill.)—*Stahl und Eisen*, Nov. 15th, 1899, Vol. XIX., No. 22.

Energy Meter.—*Aron Energy-Meter with Automatic Rewinding.* By J. Reyval. Description of a new type of Aron Meter, in which the necessity of periodical winding is abolished. Other advantages appear to be permanence of standardization, freedom from thermal and magnetic errors, and accuracy of records, with both alternating and direct current. 7 pp.—*Ed. Electr.*, June 17th, 1899. Sc. Abs., Dec. 1899.

Engraving Machine. — *Electric Engraving Machine.* F. J. Patton. This is an application of the electric Pantograph to the process of engraving upon wood or metal. Instead of merely tracing, the stylus is arranged to cut lines to any desired depth.—*Elect. World and Engr.*, pp. 306-307, Aug. 1899. Sc. Abs., Dec. 1899.

Fuel and Energy.—*Influence of Cheap Fuels on the Cost of Electrical Energy.* By R. E. Crompton. Abstract of a paper read before the Institution of Electrical Engineers, Nov. 23rd, 1899.

Influence of Cheap Fuel on the Cost of Electrical Energy. 1¼ cols.—*Elec. Rev.*, Dec. 1st, 1899, No. 1,149.

Generators. — *Compensating Revolving Field-Generator.* Description of Apparatus constructed by the General Electric Company, New York. (Ill.) 4 cols.—*Elec. Rev.* (New York), Nov. 22nd, Vol. XXXV., No. 21.

Generating Set.—*Recent Development in Marine Generating Sets.* Summary of Bulletin, No. 0733, issued by the manufacturers, the Bullock Electric Manufacturing Company, Cincinnati, Ohio. (Ill.) 1¾ col.—*Elec. Rev.* (New York), Nov. 1st, 1899, Vol. XXXV., No. 18.

Plant in Steel Works.—*Electric Power in Steel Works.* Electro-magnetic Cranes in the works of the Illinois Steel Company in South Chicago. (Ill.). 1 col.—*Elec. Rev.*, Nov. 17th, 1899, No. 1,147.

Plant on Board Ship.—*Electrical Machinery on Board Ship.* A. Siemen's Abstract of a paper read before the British Association, 1899. The author points out the advantage of electric power on shipboard arising from the absence of cumbersome leaking pipes, and mentions among the drawbacks that a strain on a winch often stops the auxiliary machinery. In such cases shunt-wound motors driving through friction clutches are used. 1 col.—*Electrician*, Sept. 1899. Sc. Abs., Dec. 1899.

Plant for Coal Mines.—*Electricity in Coal Mines.* H. N. Gardner. The article describes methods for designing electrical machinery for mining work so as to escape the dangers from rough usage and dirt. 4 cols.—*Amer. Electn.*, Aug. 1899. Sc. Abs., Dec. 1899.

Power Application.—*Electrically-Driven Workshop of the Allgemeine Elektricitäts Gesellschaft.* Article describing the remarkable development of that German factory in which up to 2,000 h.-p. is absorbed. (Ill.). 3 cols.—*Electrician*, July, 1899. Sc. Abs., Dec. 1899.

Rotary Converters.—*Converters* (Rotary), by H. T. Parshall, M.Inst.C.E., and H. M. Hobart, S.B. (continued). 6 cols. (Ill.). *Engng.*, Dec. 8th, 1899, No. 1771.

Some Notes on Rotary Converters, with special reference to the extension plant of the Chicago Edison Company. By A. C. Eborall (continued). 3 cols.—*Elec. Rev.*, Dec. 1st, 1899, No. 1,149.

Storage Batteries.—*Storage Battery in Telephone Exchanges.* Description of a typical telephone installation in the exchange of the Bell Telephone Company, of Philadelphia. (Ill.). 2½ cols.—*Elec. Rev.* (New York), Nov. 8th, 1899. Vol. XXXV., No. 19.

Testing.—*Methods of Dynamo Testing.* 3 cols.—*Engr.* (New York), Nov. 1st, 1899, No. 490.

Transmission.—*Rotaries in the Hartford Plant.* By W. L. Robb. 2 cols.—*Journal of Electricity* (San Francisco). Vol. VIII., No. 4.

Electric Transmission of Power.—Hydro-Electric Plant at Rheinfelden. 5 cols.—*Engng.*, Nov. 10th, 1899, No. 1,767.

4. Telegraphy and Telephony.

Fuse-Wires.—*Fuse Wires for Air-lines.* By J. Mattausch. The author proposes, in localities where aërial lines may be endangered by lightning or currents from other neighbouring circuits, to introduce fuses into every span of wire so arranged that the line wires bear no strain upon the fuse wires. 2 pp.—*Zeitschr. Elektrotechn.*, Vienna, 1899. Sc. Abs., Dec. 1899.

Lightning Arresters. — *Lightning Arresters.* Bochet. The paper contains an illustrated description of various lightning arresters for the protection of electric lines, and a discussion of the conditions which constructers of lightning arresters should take into account.—*Soc. Int. Elect.*, Bull. 16 pp. 184-207, 1899.

Multiplex Telegraphy.—*Mercadier's Multiplex Telegraphy.* This system, described already in the *Annales Télégraphiques* of 1891, consists in "turning" a set of telephones, so that each responds to an alternating current of one, and one only periodically. These "monotelephones" may be connected in series, one at each station, and any particular station can be signalled by the corresponding alternating current. The present article describes the arrangement of circuits and apparatus, and states that the system is more economical than preceding systems.—*Elektrotechn. Ztschr*, 1899, pp. 305-307, 318-320, 336-337. Sc. Abs., Dec. 1899.

Wireless Telegraphy.—*Wireless Telegraph Repeater.* Description of an apparatus, invented by Emile Guarini-Foresio for repeating wireless telegraph signals, and for sending or receiving such signals in the ordinary way. (Ill.) 1½ col.—*Elec. Rev.* (New York), Nov. 15th, Vol. XXXV., No 20. See also (1½ col.) *Elec. Rev.*, Nov. 10th, 1899, No. 1,146.

5. Miscellaneous.

Arcs in Switches.—*Methods of Suppressing Arcs in Switches, Fuses, &c.* Abstract of a paper by Ernest Kilburn Scott, A.M.I.C.E. (Ill.) 3 cols. (To be continued.)—*Elec. Engr.*, Dec. 8th, 1899. New Series, Vol. XXIV., No. 23.

Batteries. — *Iron-Consuming Batteries.* By J. Waterhouse. Description of a battery using iron instead of zinc in Daniell cells, in which no trouble is caused by deposits of basic iron. 1½ col.—*Soc. Chem. Ind. Journ.*, June, 1899. Sc. Abs., Dec. 1899.

Germain's Primary Battery. Account of a type of Leclanché battery, in which the electrolyte is retained between the plates by cellulose. 1½ col.—*Ed. Electr.*, June 19th, 1899.

Dangers.—*The "Latent Dangers" of Electricity.* By W. T. Hedley, M.D. 1¼ col.—*Elec. Rev.*, Dec. 8th, 1899, No. 1,150.

Dark Lightning.—*Lightning: The Dark Flash.* The article points out that what is known as a "dark" flash or "dark" lightning is due, as Lord Kelvin foresaw, to a retinal effect, and is not a physical phenomenon. This was to some extent proved already experimentally by Mr. Clayden, and has been fully confirmed by recent experiments made by Dr. William Lockyer. 2 cols.—*Engng.*, Dec. 1st, 1899, No. 1,770.

Dynamograph.—*A Metal Dynamograph.* By Paul Mellen Chamberlain. Description of an apparatus built in the shops of the Lewis Institute, and

serving as a part of the experimental laboratory equipment. (Ill.). 2 cols.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Heating Apparatus.—*Electric Heating Apparatus.* Article accompanying illustrations of a variety of electric heating apparatus made for constant-potential circuits up to 220 volts by the United Electric Heating Company, of Detroit, Mich., U.S.A. ¾ col.—*Elec. Rev.* (New York), Nov. 1st, 1899, Vol. XXXV., No. 18.

Electrical Progress.—*Inaugural Address read before the Institution of Electrical Engineers.* (Nov. 16th, 1899.) By Prof. Silvanus Thompson, D.Sc. (To be continued.) The author remarks that in Telegraphy there is not much change though there is an obvious tendency toward increased use of automatic reading. The substitution of delicate optical receivers, working by photography, opens a further field of progress. Regarding Telephonic progress he censures Great Britain for permitting the microphone, "freely given to the world by its too generous inventor" to be exploited by monopoly. In electric lighting the high prime-cost of electric wiring remains still an obstacle owing to the prejudice of the authorities against the use of uninsulated or semi-insulated return conductors. In the distribution of electrical power, larger areas of supply are a necessity of the time. 3½ cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

Inaugural Address read before the Institute of Electrical Engineers. (Nov. 16th, 1899). By Prof. Silvanus Thompson, D.Sc. (continued). Passing from the generation of the current to its utilization, Prof. Thompson points out the notable progress in the application of the electric power to heavy railways. As regards Tramways the problem of the hour is equipment of busy city thoroughfares. He, personally, is in favour of the surface-constant system for that purpose. 4½ cols. —*Engng.*, Dec. 1st, 1899, No. 1770.

Electrostatics.—*Electrostatic Rotation II.* By Alfred G. Dell. 1¾ col.—*Elec. Rev.* (New York), Nov. 22nd, 1899, Vol. XXXV., No. 21.

Influence Machine.—*The Pidgeon Influence Machine.* 4 cols. (Ill.).—*Elec. Rev.*, Nov. 10th, 1899, No. 1146.

Interfering Currents.—*Currents and the Stability of Structures.* Article discussing the interference of currents created by neighbouring electrical railways, with the work carried on in scientific laboratories. 2½ cols.—*Engng.*, Dec. 8th, 1899, No. 1771.

New Separator.—*An Electro-Magnetic Separator* (designed by Mr. John Bromilow, of Heywood, near Manchester). The main feature of this apparatus is the use of electro-magnets instead of permanent magnets, which permits them to be controlled. It is to be used for dealing with metal filings and ash metal in brass foundries. ¾ col. (Ill.).—*Engr.*, Dec. 1st, 1899.

Parabolic Wave.—*The Current Produced in an Induction Coil by a Parabolic Wave.* Article by Alexander Russell, M.A. 2½ cols.—*Elec. Rev.*, Nov. 10th, 1899, No. 146.

Regulators.—*Regulation of Alternating Current Generators.* C. L. Cory. Abstract of a paper read before the Pacific Coast Electric Transmission Association, San Francisco, June 20-21, 1899. The author points out that the chief item affecting the regulation of an alternating current generator is the power factor of its load.—*Journal of Electr.*, 8 pp., 33-40, Aug. 1899. Sc. Abs., December, 1899.

Thawing Water-Pipes.—*Thawing Water-Pipes with Electricity.*—Account of employment of alternating currents passing through the pipes. A pressure of 20 to 56 volts is used, obtained from a portable transformer connected with the street mains. A current of 300 to 400 ampères is passed through the frozen pipe, which usually in a few minutes causes the water to flow freely. 2 pp.—*Canad. Electr. News*, 1899, pp. 57-58. Sc. Abs., Dec. 1899.

Volta. *Volta and Voltaic Cells.*—Summary of a lecture delivered by Prof. Righi in Como, Italy, Sept. 18th, 1899. 1¾ col. (to be continued).—*Elec. Rev.* (New York), Nov. 22nd, 1899, Vol. XXXV., No. 21; Sept. 18th, 1899 (continued), 10 cols.; Nov. 29th, 1899, Vol. XXXV., No. 22.

Wool Removing. *Wool Removed from Skins Electrically.*—Account of an electrical knife made of platinum-iridium wire rendered incandescent by a current of about 60 ampères at 4 volts.—*Electrician*, June 30th, 1899, p. 333. Sc. Abs., December, 1899.

MARINE ENGINEERING AND SHIPBUILDING.

Car-Ferries.—*Car-Ferrying on the Great Lakes*, by Waldon Fawcett. The author describes several vessels of the considerable fleet of car-ferries on the American Lakes, which make several trips daily, every day of the year, and in the winter months are compelled to plow their way through fields of ice, varying in thickness from 3 to 4 ft. (Ill.) 4½ cols. *Loc. Engng.* (New York), Dec. 1899, Vol. XII., No. 12.

Coaling at Sea.—*Vessels* (*Coaling at Sea*). Paper read by Mr. Spencer Miller before American Society of Naval Architects in New York, Nov. 16th and 17th. 1½ cols.—*Engng.*, Dec. 8th, 1899, No. 1771.

Fishing Boats. The Maritime Fisheries Exposition at Bergen. M. J. Pérard. Article describing fishing boats and their appliances. (Ill.) 13 cols. —*Bull. de la Soc. d'Encour.*

German Fleet.—The Development of German Shipbuilding. Concluding article of an excellent series of papers by M. Haack, summing up the economic and sociological factors of the remarkable growth of German industry, as shown in her extensive ship-building. 2½ cols.—*Engng. Magazine*, Nov. 1899.

Liner.—*The New Australian Liner "Ortona."*—1 col.—*Engng.*, Nov. 24th, 1899, No. 1769.

Life-Saving.—*Organization and Development of the United States Life-Saving Service.* An account of the work carried on from data furnished by Summer J. Kimball, chief of the service. 2½ cols. (Ill.)—*Mar. Rev.*, Oct. 12th, 1899.

Merchant Vessels.—*Establishment of an American Merchant Marine.* Eugene Taylor Chamberlain. Review of the merchant marines of maritime nations and their systems, and comments on America's activity with regard to her future. 2½ cols.—*Mar. Rev.*, Oct. 12th, 1899.

Oceanic.—*Magnificent Decorations and Furnishings of the "Oceanic."* Illustrated description. 1½ cols.—*Mar. Rev.*, Oct. 12th, 1899.

Oceanic.—*Windlass and Capstan Gear of R.M.S. "Oceanic."* Illustrated description of gear for the working of cables 3½ ins. in diameter. 1 col.—*Engng.*, Oct. 6th, 1899.

Paddle Wheel Steamers.—*Early Paddle Wheel Steamships.* Description of the Hudson River steamers, and steamers of the Fall River Line. 2 cols. (Ill.)—*Engr.*, Oct. 13th, 1899.

Progress in Japan.—*The Shipping and Shipbuilding of Japan.* This is a short summary of the present status of things in that country, based upon the official list for 1899 of the Mercantile Marine Bureau of the Department of Communications at Tokyo. 1 col.—*Engr.*, Dec. 1st., No. 2292.

Radial Valve Gear.—*Long Radial Valve Gear.* Lincoln A. Lang. Description of new gear used

in several small steam vessels on the Great Lakes in America. 2 cols.—*Mar. Rev.*, Oct. 1899.

Shipbuilding. — *Marine Engineering and Shipbuilding on the Thames.* Short account of the work in progress. 2 cols. (Ill.)—*Engr.*, Sept. 29th, 1899.

Shipbuilding Plant of Wolff and Zwicker, at Portland, Or., on Pacific Coast. Short illustrated account. ½ col.—*Marine Engrg.*, Oct. 1899.

Ship's Boats.—*Improved Appliances for Launching Ship's Boats.* Abstract of a Paper by John Hyslop, presented at the general meeting of the Society of Naval Architects and Marine Engineers, held in New York on Nov. 16 and 17, 1899. (Ill.). 1¾ col.—*Engrg. News* (New York), Nov. 28th, 1899, Vol. XLII., No. 21.

Steamships. — *The Cunard Liner "Ivernia."* Description of the main features of the new vessel. 2 cols.—*Engng.*, Sept. 22nd, 1899.

Fast Cross-Channel Steamer. G. H. Parsons. A paper read before the British Assoc. at the Dover meeting, and describing a projected 30-knot turbine boat. 1 col.—*Engng.*, Sept. 22nd, 1899.

Stern Wheel River Steamboat for the Klondike Trade. Illustrated account of the *Willie Irving*, plying on the upper Yukon river. 1 col.—*Marine Engng.*, Oct., 1899.

Transportation. — *Taking Steamers by Inland Route to the Caspian Sea.* Article describing the method used for transporting the twin-screw steamer *Meridian* from St. Petersburg through the Marinski canals and down the Volga. ½ col.—*Engr.*, Sept. 22nd, 1899.

Tug Boats.—*Type of Fire Tube Boiler adapted for Tug-boat Service.* Comments on the inadequate designs of boilers used for tug-boats, and description of a single-ended Scotch boiler to carry 125 lbs. of steam-pressure. ½ col. (Ill.)—*Marine Engng.*, Oct. 1899.

Yachts.—*Consideration of the Steam Yacht from the Designer's Point of View.*—William A. Fairburn. Description of famous yachts with their classification into groups (continued). 2½ cols.—*Marine Engng.*, Oct. 1899.

The Steam Yacht "Josephine."—Short account of a beautiful yacht built for P. A. B. Widener, of Philadelphia. 1 col.—*Sci. Am. Sup.*, Oct. 7th, 1899.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, Fuel.

Boiler and Feed Pump. — *Compound Direct-Acting Boiler Feed Pump.* — (Ill.). ¾ col.—*Engng.*, Dec. 1st, 1899, No. 1770.

Coal Dust Fuel.—*The Freitag Apparatus for Coal Dust Fuel.*—Translation of article by L. Kaufman in "Zeitschrift d. Ver. Deutscher Ing.," describing an improved system of automatic stoking with coal dust. 1½ col.—*Coll. Guard.*, Sept. 22, 1899.

Cost of Steam Raising —*The Cost of Steam Raising.*—By John Holliday, Ass. Mem. Inst. C.E. Paper read before the Institution of Electrical Engineers. (Ill.). 4 cols. (to be continued). —*Engng.*, Dec. 8th, 1899, No. 1771.

Imperfect Boilers.—*Heat Losses from Imperfect Boiler and Cylinder Covering.*—Summary of a lecture delivered by Captain Wallace W. Johnson before the Railway Engineering Class, Sibley College, Cornwall University, U.S.A. 3½ cols.—*Soc. Engng.* (New York), Nov. 1899, Vol. XII., No. 2.

Liquid Fuel.—*Kermode's* Apparatus for Burning Liquid Fuel. (Ill.)—*Engng.*, Nov. 17th, 1899, No. 1768.

Testing Fuel.—*Test of Fuel by means of Röntgen-Rays.*—By F. Cotte, of Duisburg. The article describes the result of experiments made in the physical laboratory of the "Kgl. Maschinenbau und Hüttenschule" at Duisberg, in order to test the impurity of coal caused by admixture of slate, &c. In their experiments the opaqueness of certain substances for the X-rays was utilized to determine the pressure of foreign substances in coal which permits the rays to pass. 6½ cols.—*Stahl u. Eisen*, Nov. 1st, 1899, Vol. XIX., No. 21.

Water Tubes.—*Reasons for the Adoption of Water Tube Boilers in the U.S. Navy.*—Abstract of a paper read at the Seventh General Meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 16th and 17th, 1899. 4½ col. *Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Boilers (Water-Tube).—Paper read by Admiral George W. Melville, Engineer-in-chief, U.S. Navy, before Society of Naval Architects in New York, Nov. 16th and 17th. 2 cols.—*Engng.*, Dec. 8th, 1899, No. 1771.

2. Compressed Air.

Air Lift Pumps —*The Pohlé Air-Lift Pump.* Extract from a paper by Mr. Charles Wood, of Middlesbrough, read before the Cleveland Institution of Engineers on "Raising or Lifting Water by Air," in which he described the Pohlé air-lift system for raising water from artesian wells by means of compressed air without the employment of any moving parts. (Ill.). ½ col.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

3. Engines and Motors.

Automobilism.—*Balancing of Motors.* H. E. Wimperis' comments on important points with reference to balancing motors and reducing vibration. 1 col.—*Automotor Jour.*, Oct. 1899.

Recent Experiences with Steam on Common Roads. —John I. Thornycroft. The author dwells on the importance of building durable vehicles, and describes some that have been built to his designs. (Ill.). 5 cols.—*Engng.*, Sept. 1899.

The Siemens and Halske Electric Street Omnibus. —H. Siebert. Description of an automobile omnibus, using both overhead wire and accumulators, and giving details of the motor and controller. 3 cols.—*Elektrotechn Zeitschr*, Sept., 1899.

A Missing Link Vehicle.—Description of a detachable motor that may take the place of the front wheels of any vehicle and thus convert the latter into an automobile. 1½ cols.—*Autom. Mag.* (New York), Oct. 1899.

Heavy Motor Car Trials in France.—Comments on the competition between automobiles held recently at Versailles. 1½ cols.—*Engr.*, Oct. 20, 1899.

Secor's Kerosene Burning Motor.—Hugh Dolnar. Description and comments on the motor. (Ill.). 1 col.—*Am. Mach.*, Oct. 5th, 1899.

Some Inaccuracies Corrected.—J. D. Lynn. Criticism of statements made by Hugh Dolnar in an article published in the *American Machinist.* ½ col.—*Am. Mfr. & Ir. Wld.*, Oct. 19th, 1899.

Electrically Driven Automobiles.—C. P. Feldmann. A review of the automobiles in which electric motor power was used, shown at the recent Paris competitions. 2½ cols.—*Elektrotechn. Ztschr.*, Oct. 1899.

The Genesis of the Automobile. — John Grant Cartaret. History of the progress since the 17th century. (Ill.). 2 cols.—*Autom. Mag.* (New York), Oct. 1899.

The Removal of Odours from Electric Battery Vehicles.—R. Ulbricht. Description of devices for ventilating the batteries of electric automobiles so as to prevent the unpleasant odours. 1 col.—*Elektrotechn. Ztschrft.*, Sept. 1899.

Cycles.—*Cycles and Motor Cars at the Stanley Show.* 6 cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

Cycles and Motor Cars at the National Show. (Ill.). 6½ cols.—*Engng.*, Dec. 1st, 1899, No. 1770.

Corliss Engines.—*The Construction and Operation of Corliss Engines.* A History and Description of the Corliss Engine. Eighteen pages illustrated.—*Engr.* (New York), Nov. 15th, 1899, No. 491.

Fire Engines.—*Self-propelled Fire-Engine.* 2 cols. (Ill.). Including illustrations.—*Engng.*, Nov. 24th, 1899, No. 1769.

Gas Engines.—*High Power Gas Engines.* Description of Washington Gas Engine, 250 h.-p. (Ill.). 1½ col.—*Engr.*, Nov. 10th, 1899, No. 2289.

Utilisation of High Furnace Gases for Power in Gas Engines.—By Bryan Donkin, M.Inst.C.E. 2¾ cols. (Ill.).—*Engr.*, Nov. 24th, 1899, No. 2296.

A Gas Engine and Fuel-Gas Producing Power Plant. Description of a plant designed and built by R. D. Wood & Co., of Philadelphia, U.S.A., and erected by them at the new shops of the Erie R.R. in Jersey City. (Ill.). 1½ cols.—*Engng. News*, Nov. 28th, 1899, Vol. XLII., No. 21.

The Model Gas and Gasoline Engine. Description of an engine invented by Warren E. White, and manufactured by the Garrett Gas Engine Company, Garrett, Ind., U.S.A. (Ill.). 1 col.—*Am. Mfctr.*, Nov. 30th, 1899, No. 22.

Hydraulic Machinery.—*Some Notes on the Manufacture of Hydraulic Machinery, gathered in the Shops of the Watson-Stillman Co.* Comments on machinery. (Ill.). 2 cols.—*Mach.* (New York), Oct. 1899.

Oil Launch Engines.—*Launch Oil Engine* (Built by the Griffin Engineering Company of Bath). 3 cols. (Ill.).—*Engr.*, Dec. 1st, No. 2292.

The Griffin Oil Launch Engine. (Ill.). 3 cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

Reversing Engines.—*Reversing Engines for Rolling Mills.* L. Ehrhardt. Full description with indicator diagrams and plans of vertical three-cylinder reversing roller-mill engine. 4 cols.—*Stahl u. Eisen*, Sept. 15th, 1899.

Rotary Converters.—*The Design of Rotary Convertors.* H. F. Parshall, M.Inst.E.E., and H. M. Robart, S.B. (continued). ¼ col. (Ill.). *Engng.*, Nov. 17th, 1899, No. 1768.

Shaft Governor.—*The Robinson Shaft Governor.* ¼ col.—*Engng.*, Dec. 1st, 1899, No. 1770.

Steam Engines.—*Simple and very Economic Steam Engine.* This engine, designed by Elihu Thompson for automobile work, has four cylinders of 2½ in. diameter and 3-in. stroke, the output of the four being 5 H.-P. The economy obtained reached 20½ lbs. of water per H.-P., the steam pressure being between 160 and 200 lbs., with a considerable degree of super-heating. The conditions of working are such that there is no retraversing of any of the passages by the steam, which always moves in one direction so that there are no interactions to cause waste of energy.—*Amer. Electn.* Il., pp. 208, 199. Sc. Abs., Dec. 1899.

The Buffalo Horizontal Centre-Crank Engine. Description of several types of steam engines now manufactured by the Buffalo Forge Company, of Buffalo, N.Y., U.S.A. (Ill.). 2 cols.

Stress of Material.—*Working Stress of Material in Locomotives.* Paper read by F. W. Jennings before the North East Coast Institution of Engineers and Ship Builders. 7 cols.—*Engng.*, Nov. 10th, 1899, No. 1767.

Tank Engines.—*Locomotive Tank Engines.* Description of two-tank engines of the Central London Railways, built by the Hunslet Engine Company, Leeds. (Ill.). 2½ cols.—*Engr.*, Nov. 17th, 1899, No. 2290.

Traction Engines.—*Traction Engine and Military Train.* Description of engines and vans manufactured by J. and H. McLaren, of Leeds. (Ill.). 1¼ col.—*Engr.*, Nov. 24th, 1899, No. 2291.

Triple Expansion Engines.—Triple Expansion Engines, H.M.S. "Oceanic." (Ill.) 1 col.—*Engr.*, Dec. 1st, 1899, No 2292.

Turbines.—*Steam Turbines.* Article commenting on the presidential address delivered by the Hon. Charles A. Parsons, before the Institution of Junior Engineers on Nov. 3rd, 1899. 2½ cols.—*Engng.*, Nov. 10th, 1899, No. 1767.

The Turbines of the Hydraulic Power Transmission at Rheinfelden.—F. Prásil. Article giving details of construction and description of the regulating apparatus. 2 cols.—*Schweizer Bauztg*, Oct. 7th, 1899.

Valves.—"*New Valve for fast running Blowing Engines.* F. W. Lührmann. The article describes the valves that were discussed in the last meeting of the "Verein deutscher Hüttenleute," and at the meeting of the American Society of Mechanical Engineers at Washington. (Ill.). 2½ cols.—*Stahl und Eisen*, Nov. 15th, 1899, Vol. XIX., No. 22.

4. Power and Transmission.

Pile Drivers.—*Two Railway Pile Drivers.*—Description of two somewhat novel pile drivers designed by Mr. G. W. Smith, Assistant-Superintendent of Bridges and Buildings, of the Chicago, Milwaukee, and St. Paul Railway. (Ill.). 3½ cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Steam Packers.—*Friction of Steam Packers.* By Chas. Henry Benjamin. (Ill.). 4 cols.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Weighing Machines.—*Grain-Weighing Machine* (Automatic), constructed by Messrs. W. & P. Avery, Ltd., Engineers, Birmingham. (Richardson's patent). ¾ col. (Ill.)—*Engng.*, Dec. 8th, No. 1771.

Water Wheels.—*Tangential Water Wheels.* By W. A. Doble, M.E. Abstract of a paper read before the Thirtieth Annual Convention of the American Institute of Mining Engineers, San Francisco, Cal., U.S.A. (Ill.). 7 cols.—*Journal of Electricity, etc.* (San Francisco), Oct., Vol. VIII, No. 4.

5. Machine Works, Shop and Foundry.

Ball Bearings.—*A Theoretical Study of Ball Bearings.* Prime Gazarine. A mathematical investigation of the action of the ball bearings in the Stokes anemometer, with reference to the subject in general. 1½ cols.—*Génie Civil*, Oct. 7th, 1899.

Castings.—*Casting a Cylinder in Dry Sand.* R. H. Palmer. Detailed description. 3 cols. (Ill.). *Am. Mach.*, Oct. 1899.

Manufacture of Cast Steel Voussoirs for the Alexander III. Bridge, Paris.—Description of the foundry methods adopted, giving the more important details. 2½ cols.—*Eng. News* (New York), Oct. 1899.

Cranes.—*Machining Crane Checks.* Joseph Horner. Comments on the English practice in crane building. 1½ cols. (Ill.). *Am. Mach.*, Oct. 5th, 1899.

The Machining of Crane Girders.—Joseph Horner. Description of the machining of cross girders of cranes by the aid of templets. 1 col. (Ill.).—*Am. Mach.*, Oct. 26th, 1899.

Drilling.—*Universal Slotting, Drilling, and Milling Machine.* Constructed by the Russian Locomotive and Machine Construction Company, of Kharkoff in southern Russia. (Ill.) ¼ col.—*Engng.*, Dec. 1st, 1899, No. 1770.

Drill Press.—*Double Radial Drill Press.* Description of a special tool for drilling the field rings of large electric generators. The drills are driven by electricity, and the article gives full details of

construction and working. 1½ cols.—*Ztschr. d. Ver. Deutscher Ing.*, Sept. 23rd, 1899.

Machine Tools.—*British and American Machine Tools. II. Their comparative efficiency.* One of the factors of the superiority of American tools is said to be the fact that many firms specialise and confine their attention to the turning out of large quantities of machines in small variety. 3 cols. (Ill.)—*Engr.*, Dec. 1st, No. 2292.

Machine Tools at Stanley Show.—(Ill.) 7 cols.—*Engng.*, Nov. 24th, No. 1769.

Machine Tools at the Cycle Shows.—Description of some of the Tools exhibited at the Stanley and National Cycle Shows. (Ill.) 4 cols.—*Engr.*, Nov. 24th, 1899, No. 2291.

Machine Tools at the National Show.—(Ill.) 4½ cols.—*Engng.*, Dec. 1st, 1899, No. 1770.

Automatic Machine Tools.—(Ill.) Supplement comprising 16 pages, describing some modern machine tools.—*Engr.*, Nov. 17th, 1899, No. 2290.

Machine Works.—*A Modern Machine Works.* Description of the new works of Ludwig Lowe & Co., at Berlin. 4 cols. (Ill.)—*Ztschr. d. Ver. Deutscher Ing.*, Sept. 30th, 1899.

Melting Furnaces.—*The Construction of Brass Melting Furnaces.* E. Millet. Abstract of a paper read before the American Foundrymen's Association. (Ill.) 1 col.—*Am. Mach.*, Oct. 26th, 1899.

Polishing.—*Polishing Machinery.* Description of general and special tools and devices, and their use and working. (Ill.) 3½ cols.—*Revue Technique*, Sept. 10th, 1899.

Screwmaking.—*Screw-Machine* (Automatic) made by Messrs. Alfred Herbert, Ltd., of Coventry. (Ill.) 2 cols.—*Engng.*, Nov. 10th, No. 1767.

Weaving Machinery.—*A new Method of Making Jacquard Cards by Photography.* This is a description of the Szczepanik process, in which the design is photographed through a perforated screen. 2½ cols.—*Génie Civil*, Sept. 30th, 1899.

6. Miscellaneous.

Elasticity.—*The Elastic Equilibrium of a Rectangular Plate.* Maurice Levy. A mathematical essay deducing fundamental equations for given conditions. 1 col.—*Comptes Rendus*, Oct. 9th, 1899.

Bicycles.—*Description of some Innovations in Cycles* at the Cycle Shows. (Ill.) 2½ cols.—*Engr.*, Nov. 27th, 1899, No. 2291.

Incandescent Oil Light.—*High Power Incandescent Lighting by Oil.* Description of a system invented by Mr. Arthur Kitson, of Philadelphia. (Ill.) 2 cols.—*Journal of Gas Lighting*, Nov. 28th, 1899, No. 1907.

MINING AND METALLURGY.

1. Coal and Coke.

Auditing.—*A Colliery Audit.* George Johnson. Comments on the duties of an auditor. 1½ col.—*Coll. Guard.*, Oct. 6th, 1899.

Bohemia.—*Brown Coal-Mining in Bohemia.* (To be continued). History of the industry. 1 col.—*Coll. Guard.*, Sept. 22nd, 1899.

Coal-Cutting.—*Improvements in Coal-Cutting Machinery.* Description of a new tunnelling machine especially adapted for the rapid opening of new mines. 1½ col.—*Coll. Guard.*, Oct. 6th, 1899.

Coal Fields.—*The Coal Fields and Ore Deposits of China.* Abstract of a recent report by Mr. G. G. H. Glass, C.I.E., Mech. Inst. C.E., on the work done in connection with the expedition to China, undertaken by himself on behalf of the Pekin Syndicate, Ltd. 2½ cols.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

The South-Eastern Coal Field.—Abstract of papers, read by R. Etheridge and Prof. Boyd Dawkins, at the Dover Meeting of the British Association. The first deals with the relation between the Dover and Franco-Belgian basins; the second comments on the value of this area. 1½ cols.—*Coll. Guard.*, Sept. 22nd, 1899.

Grand River Coal Field of Colorado.—Arthur Lakes. Article dealing with the geology of the carboniferous basins. (Ill.). 3 cols.—*Mines and Min.*, Oct. 1899.

An Illinois Coal Field.—A. Dinsmore. This contribution describes the geological features of the country, the history of its coal mines, and the system of working them. 3½ cols.—*Mines and Min.*, Oct 1899.

The Coalton Coal Field.—Andrew Roy. Amount of coal mining and coal mines in an interes ing part of Kentucky. ½ col.—*Mines and Min.*, Oct. 1899.

The Durham Coal Field.—Description of the Esk Colliery. 2½ cols.—*Coll. Guard.*, Dec. 8th, 1899.

Coke.—*The Yield of Coal in Coking.* Duncan Anderson, jr. Comparison of the yield and kind of coke as obtained from, the beehive oven, retort oven and platinum crucible respectively. 1½ col.—*Ir. Age*, Sept. 28th, 1899.

The Modern Competition between the various Coke Oven Systems.—The author after reviewing the Semet-Solway coke-oven pro ess, describes an improved type of the Otto ovens in which the regenerative principle has been abandoned. Nearly 1,200 of the new ovens have been erected on the Continent. One installation at the Preussen I. colliery, near Derne, contains 160 ovens combined for the recovery of bye-products. When in full work the output will be 240,000 tons of tar per annum. 12 cols.—*Stahl u. Eisen*, Nov. 15th, 1899, Vol. XIX., No. 22.

The Bauer-By-Product Coke Oven. Abstract from an article from "Stahl und Eisen" (translated), describing a new model of retort coke oven. 1½ cols.—*Am. Mfr. and Ir. Wld.*, Sept. 28th, 1899.

Colliery Guarantee.—*The Interpretation of a Colliery Guarantee.* Text of an ordinary form of colliery guarantee with an interpretation of the various clauses based upon decisions in the courts. 7 cols.—*Coll. Guard.*, Sept. 29th, 1899.

India.—*The Coal and Iron Making Resources o India.*—Abstract of the report of R. H. Mahon dealing with coal-fields and coal mining, and giving maps of the mineral areas. 4 cols.—*Ir. and Coa Trds. Rev.*, Oct. 12, 1899.

New Methods of Mining.—*New Method of Working at the Grand Combe Colliery.* Summary of a communication by M. Destival to the *Société de l'Industrie Minérale* Saint-Etienne. (Ill.). 3½ cols.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

New Zealand.—*Coal Mining in New Zealand.* Harrison F. Bulman. Account of the Westport Coal Company, Ltd., describing its system of working, &c. 3 cols.—*Coll. Guard.*, Sept. 29th, 1899.

Testing Coal.—*The Analysis of Coal by Röntgen Rays.* Radiographs of Coal, and description of the manner in which th-y were obtained. 1½ cols.—*Ir. and Coal Trds. Rev.*, Oct. 13th, 1899.

The application of Röntgen Rays for the Determination of the quantity of ash in Fossil Minerals. Article illustrated by radiographs showing in what way the presence of siliceous matter in coal is revealed. 1½ col. (Ill.)—*Glückauf*, Sept. 16th, 1899.

Screening Plant.—*The new Screening Plant at the Witzkowitz Colliery* (Dombran). Summary of an article by A. Fillunger in the "Oestereichische Zeitschrift für Berg und Hüttenwesen. 1½ cols. (Ill.).—*Coll. Guard.*, Oct. 13th, 1899.

Spontaneous Combustion.—*Method of ascertaining whether a Coal may be safely stored or shipped.* Abstract of an article by O. Lang, in "Glückauf," referring to conclusions arrived at by Prof. Fischer of Göttingen. 1½ col.—*Coll. Guard.*, Oct. 13th, 1899.

2. Copper.

Arizona.—*The Copper Queen Mine, Arizona.* Summary of report in the "Trans. Am. Inst. of Min. Engs.," describing the mine and its workings (to be continued). 5 cols. (Ill.).—*Mining and Sc. Press*, Oct. 17th, 1899.

New Copper Area.—*A new resource of Copper and Gold.* Robert Norman Bell. Report regarding a new mining district in Eastern Idaho. 2½ cols.—*Mines and Min.*, Oct. 1899.

Roasting Ore.—*Roasting Copper Ore at Keswick, Cal.* Thomas Neilson. The author gives an outline of the system of heap-roasting employed there. 2 cols.—*Engng. and Min. Jour.*, Oct. 17th, 1899

Vancouver.—*The Copper Deposits of Vancouver.* Paper by William M. Brewer, Victoria, B. C. 2 cols.—*Engng.*, Nov. 17th, 1899.

3. Gold, Silver, and Diamonds.

Chlorination.—*The Chlorination of Gold Ores at Mount Morgan, Queensland.* Edgar Hall. The author gives an outline description of what is perhaps the largest chlorination mill known.—*Engng. and Min. Journ.*, Oct. 7th, 1899.

Determination of Gold.—*The Iodometric Determination of Gold.* F. A. Gooch and Frederick H. Morley. Describes iodometric testing experiments. 1½ col.—*Am. Jour. of Sci.*, Oct. 1899.

Illinois.—*The Gold-Bearing Formation of Stephenson, of Stephenson County, Illinois.* Oscar H. Hershey. Description of our isolated gold-ore deposit. 1 col.—*Am. Geol.*, Oct. 1899.

New Mexico.—*Developments in Northern New Mexico* (To be continued). Comments on works in the northern part. 1½ cols.—*Engng. and Min. Jour.*, Sept. 30th, 1899.

Wonderful Dry Places. A. W. Glifford. Reports regarding places in the Jarilla Mountains, New Mexico, yielding coarse gold, worth £20.

Sulphides.—*Concentration of Auriferous Sulphides in California.* Comments on the value of concentrating machines and the canvas plant. 1½ col.—*Min. and Sc. Press* (San Francisco), Sept. 23rd, 1899.

Unwatering.—*The Comstock Lode.* L. P. Gratacap. Description of this famous deposit, and the project of unwatering the fissure in order to resume mining after nearly 20 years of idleness. 1½ col. *Sc. Am. Sup.*, Oct. 28th, 1899.

4. Iron and Steel.

India.—*The Iron Ores of India.* Description of the ore supply in India, based on the report of Major Mahon. 4 cols.—*Ir. and Coal Trds. Rev.*, Oct. 20th, 1899.

Martin Steel.—*Improved Martin Steel or Crucible Steel.* Otto Thalnerck. Comparison between Bessemer, Open-hearth and crucible steel. The author points out that Open-hearth steel may be advantageously remelted in the crucible. 6 cols.—*Stahl u. Eisen*, Sept. 25th, 1899.

Ingots.—*Evan's Ingot Stripper.* Account of a machine constructed for stripping two ingots simultaneously. Both long and short pieces can be stripped with the same facility. 1½ col.—*Engr.*, Oct. 13th, 1899.

Open-Hearth.—*A New Open-Hearth Steel-Making Process.* Abstract from Alexander Saltmann's account in *Stahl u. Eisen*, giving the details of working and pointing out the advantages. 3 cols.—*Ir. and Coal Trds. Rev.*, Oct. 20th, 1899.

Ore Separators.—*Magnetic Ore Separators.* H. C. McNeill. Abstract of a paper read before the Iron and Steel Institute, which contains a description of the system for the magnetic concentration of ores by, Wenström, Mona, Dellvill-Gröndal, Heberle and Wetherill.—*Electrician*, pp. 639-640, Aug. 25th, and pp. 674-675, Sept. 1st, 1899. *Sc. Abs.*, Dec. 1899.

Rolling Metals.—*A Rolling Mill Engine.* Description of machinery by the Lane & Bodley Company, of Cincinnati, O., U.S.A. (Ill.). 1½ cols.—*Am. Mfctr.*, Nov. 30th, 1899, Vol. LXV., No. 22.

Improvement in Rolling Metals.—By Christian Larsen. Description of a process invented by Joseph Guest, of Pittsburg, Pa., U.S.A. (Ill.). ⅔ col.—*Am. Mfctr.*, Nov. 23rd, 1899, Vol. XLV., No. 21.

Resilience.—*Impact Tensile Tests of Steel.*—Extracts from a paper by Mr. S. Bent Russell, M. Am. Soc. C.E. (Ill.). 2½ cols.—*Engng. News*, Nov. 16th, 1899, Vol. XLII., No. 20.

Testing the Resilience of Steel.—Comments on paper by Mr. S. Bent Russell, M. Am. Soc. C.E. 2½ cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Steel.—*The Manufacture of Steel for Building Construction.*—Abstract of a paper by F. H. Kindl, Structural Engineer, Carnegie Steel Company, Ltd., read at the 33rd annual convention of the American Institute of Architects, at Pittsburgh, Pa. 2 cols.—*Engng. News*, Nov. 16th, 1899, Vol. XLII., No. 20.

The Saarbrücken Steel-Casting-Plant.—(Ill.). 3¾ cols.—*Stahl u. Eisen*, Nov. 1st, 1899, Vol. XIX., No. 21.

5. Mining.

Safety Lamps.—*An Acetylene Safety Lamp.* Extract from a communication by M. Kuhn to the *Echo des Mines et de la Métallurgie*, Paris, ½ col. —*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

Timber Calculation.—*Colliery Timber and Timber Calculations.* By George Johnson, F.S.S., A.I.S. The author explains methods for calculating the number of standards, very useful for the importers of timber for colliery purposes at Tyne Dock, Hartlepool, Hull, and other ports of Great Britain. 2½ cols.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

6. Miscellaneous.

Coal-Lease.—*An Early Durham Coal-Lease.* An ancient document, containing a deed made between the owner of Birtley estate, in Durham, and a buyer, of Newcastle-on-Tyne, dated 1325 A.D. 1⅛ col.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

Peru.—*Peru and its Mineral Wealth.* Summary of a pamphlet, dated September, published in Lima, by Mr. Ernest Thorndike. 1½ col.—*Engr.*, Nov. 17th, 1899, No. 2290.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Acetylene Gas.—*Progress in Acetylene Gas Manufacture and Apparatus.* Report of Annual Meeting of the German Acetylene Association. (To be continued.) 2¾ cols.—*Journal of Gas Lighting*, Nov. 28th, 1899, No. 1,907.

Acetylene Gas Considered from the Firemen's Standpoint. Wm. McDavitt. Abstract of an address delivered at Syracuse, N.Y., describing the dangerous properties of calcium carbides, and giving method of extinguishing fire caused by it. ½ col.—*San. Plumb.*, Oct. 2nd, 1899.

Acetylene Gas Lighting at Hawes. Account of an installation of acetylene gas lighting and the success of its working. ½ col.—*Engr.*, Oct. 13th 1899.

The Chloride of Lime Process for the Purification of Acetylene. F. B. Ahrens. Translated Abstract of account in "Zeitschr. f. Augen. Chem." The author points out the objections against the use of chloride of lime as a purifier. ¾ col.—*Journal Gas Lgtg.*, Sept. 19th, 1899.

Progress in the Acetylene Gas Industry. John B. C. Kershaw. Statement of the progress made in the generation and purification of acetylene, and its utilization. 1½ col.—*Elec. Rev.*, Oct. 1899.

Carburetted Air.—*Aërogen Gas.*—Account of Van Vriesland's carburetted air—or, as he calls it, aërogen-gas—apparatus, by Captain Franz Walter, Professor of Chemical Technology in the Austrian Imperial Technical Academy. (Ill.) 1½ col.—*Gas World*, Dec. 9th, 1899, No. 803.

Gas-Fitting.—*Pointers on Practical Gas-Fitting.* Article taken from "Sanitary Plumber." 2½ cols.—*Gas World*, Dec. 9th, 1899, No. 803.

Gas Flame Mantles.—*Incandescent Mantles.* Summary of a Report by the Photometry Committee of the German Gas Association. 1½ cols.—*Gas World*, Dec. 9th, 1899, No. 803.

The 400 H.P. Gas Producer Plant for the Erie Railroad. Description of its chief features. ¾ col.—*R. R. Gaz.*, Sept. 29th, 1899.

Gas Plants.—*Dimension of Gas Plant.* Ernest J. Sutcliffe. A tabulated account of various views concerning the size of gas plant in proportion to the work required of it. 1½ col.—*Jour. Gas Ltng.*, Oct. 17th, 1899.

A Retort-Oven Gas Plant. Second Notice. Description of Installation and Working. 2½ cols.—*Journal of Gas Lighting*, Nov. 14th, 1899, No. 1705.

The Carbonizing Plant of a Modern Gas Works. Paper read before the Institution of Gas Engineers. 2½ cols.—*Engng.*, Nov. 10th, 1899, No. 1767.

The Charlottenburg Gas Works. Plan and descriptive account of the Municipal Gas Works at Charlottenburg by Mr. A. Müller, Manager. (Ill.). 1½ col. (to be continued).—*Journal of Gas Lighting*, Nov. 14th, 1899, No. 1905.

Gas Testing.—*Industrial Gas.* VII. By Frank H. Bates. Description of method of collecting samples and of measurement of Gases. (Ill.). 6½ cols. (to be continued).—*Journal of Electricity* (San Francisco), October. Vol. VIII., No. 4.

Liability.—*Liability of a Supply Company* to meet the commands of consumers. 1 col.—*Elec. Rev.*, Dec. 8th, 1899, No. 1150.

Light Installation.—(*Interior Illumination*). Abstract of a Paper read by Mr. F. N. Morton before the American Gas Light Association. 4½ cols.—*Gas World*, Dec. 9th, 1899, No. 803.

Lighting, and the Municipal Authorities.—*The Legal Relationship of Electric Lighting or Power Corporations and Municipal Authorities.*—Summary of the main provisions which must regulate contracts between the local authorities and undertakers. 3 cols.—*Elec. Rev.*, Nov. 17th, 1899, No. 1147.

Popularity of Gas.—*Smoke Prevention and Popularity of Gas.* Aims and Objects of a new Coal Smoke Abatement Society, inaugurated by W. B. Richmond. 2½ cols.—*Journal of Gas Lighting*, Nov. 28th, 1899, No. 1907.

Water Gas.—*Professor Lunge on the Dellwick Water Gas Process.* Abstract of translation of an article in the 'Journal für Gasbeleuchtung." 2½ cols. (Ill.). *Jour. Gas Ltng.*, Oct. 3rd, 1899.

Carburetted Gas.—*Water Gas* as a Coal Gas Auxiliary. By A. G. Glasgow, M.E., M.Inst.C.E. A paper read before the American Gaslight Association, Oct. 19th, 1899. (Ill.). 3¾ cols.—*Journal of Gas Lighting*, Nov. 28th, 1899, No. 1907.

Iron Carbonage in Water Gas. Summary of a communication made by Messrs. Van Brenkeleveen and A. Ter Horst to the Dutch Journal "Het Gas." 1½ col.—*Journal of Gas Lighting*, Nov. 21st, 1899, No. 1906.

The Dellwich Water Gas Process. Report by Dr. Lunge on "Impending Changes in the General Development of Industry." 1¾ cols.—*Journal of Gas Lighting*, Nov. 14th, 1899, No. 1905.

The Recent Committee on Carburetted Water Gas. J. Carter. A paper read at Sleaford before the Eastern Counties' Gas Mngrs.' Assoc., describing the object of the Committee and the results of its labours. 7 cols.—*Jour. Gas Ltng.*, Sept. 26th, 1899.

2. Sewerage.

Drainage.—*The Main Drainage of London.* Extract from the report of the Main Drainage Committee of the London County Council, dated Nov. 2nd. 4 cols.—*Engr.*, Nov. 10th, 1899, No. 2289.

The Main Drainage of London. Greater portion of a report as to the main drainage of London, and as to the need of additional outfall sewers submitted to the London County Council. Dec. 6th. 7 cols. *Builder*, Dec. 9th, 1899, No. 2966.

Filtration.—*Bacterial Test of a Mechanical Filter at Louisiana, Mo.* Results of a test of a mechanical filter, which is treating water drawn from the Mississippi. (Ill.). 4 cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Experience with Bacteria Beds. Report to the Sanitary Institute on the water capacity, size of filtering material, and the influences on organic nitrogen. 1½ cols.—*Engng. Rcd.*, Oct. 21st, 1899.

Bacteriological Sewage Works at Hampton-on-Thames. Account of the system, and the difficulties encountered in its working. ¾ col.—*Engr.*, Oct. 20th, 1899.

Sutton Sewage Disposal Works. Results of the bacterial process, and description of the method used in employing it. 1¾ cols.—*Engr.*, Oct. 13th, 1899.

The General Distribution of the Sewage of Paris. By E. Fourrey, Inspector General of the Paris Sewers. A full account of the system used in the French capital for disposing, and transporting to the irrigation area below the city.—*Revue Technique*, Sept. 25th, 1899.

The General Distribution of the Sewage in Paris. By E. Fourrey (continued). Description of the sewage pumping machinery and the purification of the beds. 1¾ cols.—*Revue Technique*, Oct. 10th, 1899.

Recent Crowner's Experiments with Bacterial Sewage Treatment. Result of experiment of passing sewage intermittently through beds filled with coke, 4, 6, and 13 ft. deep. 2 cols.—*Engng. Rcd.*, Oct. 28th, 1899.

Stand Pipes.—*The West Arlington Stand Pipe, Baltimore.* Account of a stand pipe with a masonry tower of exceptional architectural beauty. ½ col.—*Engng. Rcd.*, Sept. 30th, 1899.

Manchester Sewage.—*Manchester Sewage.* Summary of the report of the experts engaged to investigate the question of the treatment of the sewage of Manchester. 3¾ cols.—*Engr.*, Nov. 27th, 1899, No. 2291.

Sewage.—*Manchester Sewage.* Article summarizes the experiments carried on in Manchester regarding bacterial purification of sewage, and with the filters recommended by Sir Henry Roscoe. Their success, the author points out, is likely to popularize the system in other cities also. 4 cols.—*Engng.*, Dec. 1st, 1899, No. 1770.

New Orleans Sewerage.—*Drainage and Sewerage of New Orleans.* A. N. Bell. Historical account of the sanitation work and its effect on public health. 5 cols.—*San.*, Oct. 1899.

Paris Sewage.—*Diversion and Purification of Sewage in Paris.* Article describing the system utilized for that purpose. 2¾ cols.—*Engr.*, Nov. 24th, 1899, No. 2291.

Pipe-Brush.—*Deacon's Pipe-Brush.* Description of an ingenious device for cleaning the Vyrnwy pipes. (Ill.). ½ col.—*Engr.*, Nov. 17th, 1899, No. 2290.

Storm Water.—*The Provision for Storm Water in Sewage Purification Work.* Summary of a paper by A. J. Martin, Ass. M. Inst. C.E., before the Sanitary Institute at the recent Southampton Congress. 3 cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

3. Streets and Pavement.

Garbage.—*Garbage Disposal and Street Cleaning.* W. C. Woodward. A paper read before the Am. Soc. M.I., containing an outline of the best methods. ¾ col.—*Engng. Rcd.*, Oct. 14th, 1899.

Garbage Disposal at Toronto, Ont. Description of method of collecting and cremating the garbage of that city. (Ill.). 1 col.—*Engng. Rcd.*, Oct. 21st, 1899.

Garbage Disposal at Cincinnati. Description of the method used in that city for collecting the garbage and delivering it to a company for reduction. ½ col.—*Engng. Rcd.*, Oct. 14th, 1899.

Pavements.—*Asphalt Fluxes.* W. H. Broadhurst. A report read before the Am. Soc. M.I. on experiments carried on at the Brooklyn Municipal Laboratory regarding the value of fluxes for bitumen used in paving. ¾ col.—*Engng. Rcd.*, Oct. 14th, 1899.

Brick Pavements. L. M. Hastings. A statement made before the convention of the Am. Soc. M.I. regarding the results obtained by inspecting such work in various cities. ¾ cols.—*Engng. Rcd.*, Oct. 14th, 1899.

Paving Brick and Brick Pavements. H. J. Marsh. Summary of the history of brick-making, and the cost and durability of brick pavements. 7 cols. *Jour. Ass. of Engng. Soc.*, Aug. 1899.

Wood Pavements in Indianapolis. M. A. Downing. Description of pavement of creosoted wood blocks and the method of laying them. Paper read before the Am. Soc. M.I. ¾ col.—*Engng. Rcd.*, Oct. 14th, 1899.

The Life of Pavements. Comments on a paper by G. W. Pillson on the relative destructive action of various agents, and the durability of various paving materials. 1¾ col.—*Engng. Rev.*, Oct. 21st, 1899.

Paving Plant.—*A Portable Asphalt Paving Plant of Large Capacity.* Description of a plant, built by the Iroquois Iron Works, of Buffalo, N.Y., U.S.A. (Ill.) 1½ col. — *Engng. News* (New York), Nov. 23rd, 1899, Vol. XLII., No. 21.

Streets.—*Street Grades.* Article drawing attention to the importance of fixing grades while the territory is not yet built up, and referring to the present situation in New York.—*Engng. Rev.*, Oct. 28th, 1899.

4. Water Supply.

Difficulties of Water Supply.—*Some Difficulties in obtaining a Water Supply.* By Willis J. Milner. A paper read at Buffalo before the meeting of the Am. W. Wks. Assn. (Ill.) ½ col. (To be continued.)—*Fire and Water*, Sept. 30th, 1899.

Newark Water Works.—*The Reduction of Water Waste.* Morris R. Sherrard. A paper read before the Am. Soc. M. S. describing the system used at Newark and its results. ½ col.—*Engng. Recd.*, Oct. 14th, 1899.

Philadelphia Water.—*The Improvement of the Philadelphia Water Supply.* Review of a report by Rudolph Herring, J. M. Wilkinson, and S. M. Gray, on the eventual sources of the supply, recommending filtration of river water. 2 cols. (Ill.)—*Engng. Rev.*, Sept. 30th, 1899.

Report of the Commission on the Improvement of the Philadelphia Water Supply. Statement of expert engineers appointed to investigate the subject, and to suggest plan for immediate amelioration. 2½ cols. — *Engng. News* (New York), Oct. 5th, 1899.

Water Rates.—*Water Rates.* August Herrmann. A paper read before the Am. Soc. M.I., containing an analysis of the rates in cities of over 80,000 inhabitants, showing the basis and variation of the charges, and stating some of the reasons of the difference in prices. 1¾ col.—*Engng. Rev.*, Oct. 14th, 1899.

Water Test.—*Some Results of the Systematic Organization of the Water of Public Water Supplies* X. H. Goodnough. An account of experiments made in Massachussetts, and their results. 4¾ cols.—*Jrnl. N. Eng. Water Wks. Assn.*, Sept. 1899.

5. Miscellaneous.

Assessments. — *Local Assessments.* Article describing the results of an effort in Jersey City to divide the cost of local improvements equitably among property-holders and the general population. ¾ col.—*Engng. Rev.*, Oct. 14th, 1899.

Sanitary Engineering.—*Inaugural Address by Sir Wm. Henry Preece.* Complete address describing the principles of Sanitary engineering. 5½ cols.—*Journal San. Inst.*, Oct. 1899.

Sanitation.—*The Engineering and Sanitary Renovation of Havana under the U.S. Military Government.* Abstract of General Ludlow's report, with comments by the editor. 4 cols.—*Engng. News*, Oct. 12th, 1899.

NAVAL AND MILITARY ENGINEERING.

Battleships.—*H.M.S. "London."* Description of a recently-launched vessel of a new class, with a peculiar armour system. ½ col.—*Engr.*, Sept. 29th, 1899.

Cruisers.—*New Cruisers for the American Navy.* Description of several cruisers of the "Chattanooga" class. (Ill.). 2 cols.—*Engr.*, Nov. 24th, 1899.

Flag-ship.—*Farragut's Old Flag-ship, the "Hartford."* Description of the old ship, which is to be preserved as a training ship. (Ill.). ¾ col.—*Mar. Rev.*, Sept. 28th, 1899.

German Navy.—*The Launch of the Battleship "Kaiser Karl der Grosse."* The new vessel which was launched in Hamburg, Oct. 18th, belongs to the "Emperor" class—*i.e.*, to the class containing the most powerful vessels—of which, so far, four have been launched. The article contains illustrations showing the ship at various stages of its building, and its two companions *Kaiser Wilhelm II.* and *Kaiser Friedrich III.* 5 cols.—*Stahl u. Eisen*, Nov. 15th, 1899, Vol. XIX, No. 22.

Naval Program.—*Notes on our Recent Naval Program and Designs, &c.* Account of the new projects with reference to the influence of the Spanish war, by Philip Hichborn. 1½ col.—*Mar. Rev.*, Sept. 28th, 1899.

Practice Ships.—*Construction and Equipment of the U.S. Naval Academy Practice Ship "Chesapeake."* Illustrated description of this ship, constructed as training vessel for the use of cadets. 1 col.—*Marine Engng.* (New York), Oct. 1899.

Progress in Naval Engineering.—*The Modern War-ship.* Abstract of an address delivered on the occasion of the 75th anniversary of the founding of the Franklin Institute by Rear-Admiral George W. Melville, Engineer-in-Chief United States Navy. The address consists of a very lucid review of the gradual evolution of the modern war-

vessel from its imperfect prototype in the beginning of this century. 5½ cols.—*Engng.*, Dec. 1st, 1899, No. 1770.

Range Finders.—*Range Finders and Range Finding.* Article describing various kinds of range finders and their use, notably on board ship. (Ill.). 3 cols.—*Ir. Age*, Oct. 5th, 1899.

Search Lights.—*Method of Operating Search Lights More Efficiently by Use of Dynamometers.* Alton D. Adams. Article points out the desirability of operating search lights independent of the voltage of the system from which the power emanates, and indicates the method by which to accomplish this. (Ill.). 1½ col.—*Marine Engng.*, Oct. 1899.

Ship Armour.—*Armour for New Russian Ships.* Official Report, showing the result of an extremely important plate trial—namely, the test on supply of the plates made by Messrs. Carnegie for the quick-firing batteries of the Russian battleship *Retvizan*, building at Cramp's yard, Philadelphia. 1¼ col. (Ill.).—*Engr.*, Nov. 10th, 1899, No. 2289.

Submarine Boats.—*The Lake Submarine Boat.* Description of the "Argonaut," invented by Simon Lake, and giving the facts which the inventor claims to have established. (Ill.). 1 col. —*Engr.*, Oct. 6th, 1899.

Torpedo Boats.—*American Torpedo Boats of Recent Construction.* Walden Fawcett. Article describing the qualities of these boats, and attributing superiority especially to those built on the Pacific Coast. (Ill.). 2 cols.—*Mod. Mach.*, Oct. 1899.

Our Torpedo Boat Flotilla. Walden Fawcett. Comments on the policy of the U.S. Navy with regard to torpedo boats, and the results obtained with the latest boats. 2 cols.—*Mar. Rev.*, Sept. 28th, 1899.

Turret.—*Schneider-Canet Turret (electrically worked) for 12ct. guns.* No. 72 (continued). 1½ col.—*Engng.*, Dec. 1st, 1899, No. 1770.

Electrically worked Turret for 12ct. guns. Constructed at works of Messrs. Schneider and Co., at Creusot. No. 71 (continued). 3½ cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

RAILWAY WORK.

Air Brakes.—*Air Brake Equipment for Street Cars.* Description of apparatus built by the Standard Air Brake Company, New York. (Ill.). ½ col.—*Elec. Rev.* (New York), Nov. 1st, 1899, Vol. XXXV., No. 18.

Russian Contract for Westinghouse Air Brakes. Abstract of an important communication from Mr. Holloway, U.S., Consul-General at St. Petersburg, regarding a contract for American apparatus, amounting to $15,000,000. 2¾ cols.—*Loc. Engng.*, Nov. 1899, Vol. XII., No. 2.

Air Brake Testing Plants.—Description of some devices for the purpose of adjusting the piston-travel on the air brake cars. 1½ cols.—*Loc. Engng.* (New York), Dec. 1899, Vol. XII., No. 12.

Handling Air Brake Trains. Extracts from a report of the Committee of the Travelling Engineers Association, U.S.A. 2 cols.—*Loc. Engng.*, Nov. 1899, Vol. XII., No. 2.

Fog Signalling.—*Mechanical Fog Signalling Apparatus.* Description of a system invented by Mr. V. L. Raven, Assistant Locomotive Superintendent, and Mr. Charles Baister, Assistant Locomotive Engineer, both of the North-Eastern Railway Company. This system is said to be the only one which has been used on a practical scale. 2¾ cols.—*Engr.*, Nov. 10th, 1899, No. 2289.

Locomotives.—*Locomotive Development.* Abstract of an opening address by Prof. Pullen to the Goldsmiths' Institute Engineering Society, Nov. 25th, 1899. History of the gradual evolution and perfection of the modern locomotive from the first self-propelled carriage built in 1759 to the most recent specimens. 7½ cols.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Cooke Locomotive for Wales. Description of a locomotive, built for the Port Talbot Railway and Docks Company, Port Talbot, Wales, by the Cooke Locomotive and Machine Company, Paterson, N.J. (Ill.). ½ col.—*Loc. Engng.* (New York), Dec. 1899, Vol. XII., No. 12.

A Little Compound Locomotive History. Extracts from a paper on "Compound Locomotives," presented by Mr. Fred H. Colvin at the meeting of the Junior Section of the American Society of Mechanical Engineers. 2½ cols.—*Loc. Engng.* (New York), Dec. 1899, Vol. XII., No. 12.

American Tank Locomotives for Foreign Railways. Description of locomotives built by the Cooke Locomotive Works, of Paterson, N.J., U.S.A. (Ill.). 2 cols.—*Engng. News* (New York), Nov. 16th, 1899, Vol. XLII., No. 20.

Friction Tests of a Locomotive Slide-Valve. By Frank C. Wagner. 2¼ cols.—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

Modern Locomotive Practice. By C. E. Wolff, B.Sc. 3 cols. (Ill.).—*Mech. Engr.*, Dec. 9th, 1899, No. 98.

The Cost of Steam-Raising. By John Holliday, A.M. Inst. C.E. (conclusion). A paper read before the Institution of Electrical Engineers, Nov. 23rd, 1899. (Tables.) 1¾ col.—*Coll. Guard.*, Dec. 8th, 1899, No. 2032.

Smoke Boxes.—*Draft Appliances and Extended Smoke-Boxes.* Abstract of a paper by Mr. Snowden Bell on "Locomotive Front Ends" presented to the Western Railway Club. The paper contains a history of the principal appliances used for draught inducing and spark arresting purposes. 3¾ cols.—*Loc. Engng.* (New York), Dec. 1899, Vol. XII., No. 12.

Wagon Coupler.—*Railway Wagon Coupler.* By F. A. Brockelbank. (Ill.). 1 col.—*Engng.*, Nov. 17th, 1899, No. 1768.

2. New Projects.

Railway Projects.—*Railway Schemes in Parliament.* 8 cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

Railway and Tramway Parliamentary Schemes. 7¼ cols.—*Engng.*, Dec. 1st, 1899, No. 1770.

3. Permanent-way and Fixtures.

Modern Progress.—*Modern Developments in Permanent-way Work.* By E. E. Russell Tratman, C.E. Abstract of an address delivered before the annual meeting of the Roadmasters' Association of America in September, 1899. (2½ cols., to be continued.)—*Engr.*, Nov. 17th, 1899, No. 2290.

Modern Developments in Permanent-way Work. By E. E. Russell Tratman, C.E. Abstract of an address delivered before the Roadmasters' Association of America in September, 1899 (continued). 3¾ cols.—*Engr.*, Nov. 27th, 1899, No. 2291.

Rail Bonds.—*A New Idea in Rail Bonds.* Description of rail bonds manufactured by Mr. Harold P. Brown, of New York. (Ill.). 1 col.—*Elec. Rev.*, Nov. 29th, 1899, Vol. XXXV, No. 22.

Signals.—*Automatic Signalling and Stopping of Trains at Grade Crossings.* Description of apparatus employed by the St. Louis, Peoria, and Northern Railway at Hawley, Ill. (Ill.). 1¼ col. —*Engng. News.* (New York), Nov. 11th, 1899, Vol. XLII., No. 20.

Tunnels.—*A new Tunnel over the Alps.* Article treating on the new Simplon route. 1½ cols.—*Loc. Engrng.*, Dec. 1899, Vol. XII., No. 12.

4. Transportation and Conducting.

Efficiency of Conduction. — *English and American Railways.*—This is an article giving the American side of the question whether English or American Traffic is conducted more efficiently. The author claims that high or low dividends offer no test. The American companies whose railways run through extended districts of undeveloped country cannot pay as high dividends as those which are built to accommodate already existing traffic. The prime cost of building American railways averages only about ¼th of that of building the English railways, but the income is less, as transportation is very cheap. In many railways the good-rates per ton per mile are less than one farthing. 5 cols.—*Engr.*, Dec. 1st, No. 2292.

Haulage. — *Economical Haulage.* Discussion of the claims of American engineers that railway companies in their country can haul far more cheaply than those in Great Britain. 2 cols.—*Engr.*, Dec. 1st, 1899, No. 2292.

5. Miscellaneous.

Black Smoke.—*The Black Smoke Problem.* Abstract from a paper by Arthur R. Reynolds, M.D., Commissioner of Health, Chicago, U.S.A., on "The Smoke Nuisance and the Abatement Thereof," and another by John G. Schubert, chief smoke inspector of Chicago, at the meeting of the Western Railway Club, on Oct. 17th. 3 cols.—*Loc. Engng.*, Vol. XII., No. 2.

French Railways.—*French Railways and their Work.* Le Chemin de fer du Nord. By Charles Rous-Marten. 3½ cols.—*Engr.*, Nov. 10th, 1899, No. 2289.

Great Central Railway.—*Great Central Railway* (continued from p. 625). 3¼ cols. (to be continued).—*Engng.*, Nov. 24th, 1899, No. 1769.

Great Eastern.—*Notes on the Great Eastern Railway, England.* By A. M. Bell. 4½ cols. (Ill.).—*Loc. Engng.* (New York), Nov. 1899, Vol. XII., No. 2.

Great Northern Railway. — *New Branch Line and Goods Station at Leeds.* Description of a new line and station buildings of the Great Northern Railway. 2½ cols.—*Engr.*, Nov. 24th, 1899, No. 2291.

The Great Northern Railway.—New Branch Line and Goods Station at Leeds. No. I. (continued). 1 col. (Ill.)—*Engr.* Dec. 1st, No. 2292.

The Invergarry Railway.—*The Invergarry and Fort Augustus Railway.* Descriptive article (Ill.). 3½ cols.—*Engr.*, Nov. 17th, 1899, No. 2290.

STREET AND ELECTRIC TRAMWAYS.

Diatto System.—*Diatto Surface Contact System.* J. Blondin. Description of a line at Tour, about 2 km. in length, equipped with Diatto's electro-magnetic system.—*Ecl. Electr.*, pp. 121–130, 1899. Sc. Abs., Dec. 1899.

Electric Railway. The Kashmir Electric Railway. 2½ cols.—*Elec. Rev.*, Nov. 17th, 1899, No. 1,147.

Return Feeders for Electric Railways (continued). 4½ cols.—*Elec. Rev.*, Dec. 8th, 1899, No. 1,150.

German Tramway.—*Bommern-Witten Tramway.* M. Schiemann. A description of a German electric tramway equipped by O. L. Kummer and Co., of Dresden. The power-station is equipped with steam-driven sets (150 lbs. steam, 135 revolutions per minute), and a buffer battery of dynamos. Diagrams show the parallel and brake connections of the motors and the car-wiring.—*Elektrotechn. Zeitschr.*, pp. 507–510, July, 1899. *Sc. Abs.*, Dec. 1899.

Overhead Lines.—*Overhead Line Material for Electric Railways.* By Beng. A description of trolley wire insulators, cross-wire suspension insulators, steam insulators, &c., as made by the Allgemeine Elektricitätsgesellschaft, of Berlin. A vulcanized fibre-material, called "Stabilit," is used for the insulation, the resistance of which, after being kept in a damp atmosphere for four weeks, is given by the author as 8·5 megohms per cubic centimetre. (Ill.)—*Elektrotechn. Ztschr.*, pp. 493–498, July, 1899. Sc. Abs., Dec. 1899.

TRADE AND ECONOMICS.

1. Commerce and Trade.

Competition.—*American Competition*, No. VIII. By Archibald F. Head, M.I.Mech.E., Assoc. M.Inst.C.E. The author attributes American success to both natural and sociological advantages. On the one hand there are marvellous natural resources, on the other hand the conditions of labour and the character of the people favour progress. Finally the American is ever ready to increase and develop labour-saving machinery, condemning to the scrap-heap what has become obsolete, and not dreading the expenditure for new installations, which always proves a good investment. 3½ cols.—*Engng.*, Nov. 10th, No. 1767.

American Competition, No. IX.—By Wm. Metcalf, Engineer, Pittsburg. The author illustrates the readiness with which the Americans accept improvements, and the energy which they display in obtaining "the best in the market" by the rise and progress of a crucible-steel concern. 2½ cols. —*Engng.*, Nov. 17th, 1899, No. 1768.

American Competition, No. X.—By Robert W. Hunt, Engineer, Chicago. The author attributes American success to the energy of reducing physical obstacles, lowering cost of transportation, readiness of constantly disregarding what is old fashioned, and replacing it by the more modern and practical; while on the other hand the people of Great Britain cling to old methods and apparatus as long as these appear to be "good enough." 3¾ cols.—*Engng.*, Nov. 24th, 1899, No. 1769.

American Competition, No. XI.—T. Guilford Smith, Buffalo, N.Y., U.S.A. The writer attributes the successful competition of Americans in the industrial world with other nations to what he calls, their greater *adaptability*. There exists in America ever willingness on the part of the master as well as the workman to meet the requirements of the buyers, and to conform to the conditions necessary in order to insure success; while rigidity characterises the foreign (British) competitors. 2¾ cols. —*Engng.*, Dec. 1st, 1899, No. 1770.

American Competition, No. XII.—By Robert S. Ball, Jr., B.Sc. London. The author attributes American success in competition to greater liberty of the workman to utilize his time and opportunities, to the quicker prospects of advancement, and the stimulus given thereby to make himself more useful by inventing new methods and devices for expediting his task. Standardization also enables American engineers to execute contracts more speedily and cheaply than their competitors, and much progress is due to the encouragement given to young men that possess a thorough theoretical education when entering upon practical work. 4 cols.—*Engng.*, Dec. 8th, 1899, No. 1771.

2. Currency and Finance.

3. Governmental Control.

4. Labour.

Strikes.—*Labour Troubles* (The — at Creusot), 1¾ cols. *Engineering*, Nov. 10th, 1899, No. 1767.

Wages.—*Wages and Living on the Siberian Railway.* The author claims that the remuneration of the employés is very low, while the cost of living is very high. (Ill.) 4½ cols. — *For. Engineering* (New York), Dec. 1899, Vol. XII., No. 12.

5. Miscellaneous.

REVIEWS OF BOOKS . . .

Publishers would oblige by stating the price of books sent for review.

RECENT BOOKS.

Electric Wiring, Fittings, Switches, and Lamps. By Perrin W. Maycock, M.I.E.E. London: Whittaker & Co. Crown 8vo, 446 pp., illus. 6s.

This is a volume of "Whittaker's Library of Arts, Sciences and Industries," and is calculated to fully maintain the high reputation these works have achieved. The author, Mr. W. Perrin Maycock, is already well known in connection with his elucidatory works on practical electricity, and with regard to this, his latest production, we can only say that, so far as we are able to judge, it affords no material for anything but the most cordial commendation. Mr. Maycock has dealt with a large body of material in a style so lucid, yet succinct, as to render its study a pleasure. The arrangement of its contents, and their division into numbered paragraphs are altogether admirable. Every one of the subjects, which, as may be judged from the title of the book, are sufficiently numerous, is treated with a just sense of proportion. The illustrations are just what the illustrations of such a work should be: not "pictures" but "working" illustrations, with plain references to the text, rendering an already clear style so apprehendable as to enable even a reader unversed in electricity to form a clear conception of the nature and working of the instruments, &c., treated. The author has been assisted in the preparation of his volume by Mr. C. H. Yeaman, whose Press experience would add additional value to his expert knowledge as an electrician.

The Construction of Roads and Streets. By William H. Maxwell, Assistant Surveyor and Engineer to the Leyton Urban District Council. London: St. Bride's Press. Post 8vo, 260 pp., illus., 3s. 6d.

There is such a simplicity in the appearance of any public thoroughfare that few would have any conception of the really formidable nature of the subject comprised in the title of this useful little volume. To the unlearned, it seems so easy to make a road. Many would even find themselves in a difficulty if called on to explain how Macadam's claims to distinction as an historical personage have been arrived at. It is popularly understood that he was the first man to suggest the placing of broken stone on the surface of a roadway; and while that is true in a rough sense, few outside expert knowledge on the subject appreciate the complexity of the problem Macadam solved in so simple a manner.

The construction of thoroughfares, especially that of Urban roads and streets, is now a department of engineering science, having its own formulæ and embracing many factors and conflicting theories. The comparative merits of granite setts, hard and soft wood, asphalte, and other paving materials are actively contested; and that there is a great divergency of opinion is manifest in the composition of the street pavings of any large city. The book before us gives a clear and exhaustive account of the construction of roads and streets, containing a large amount of practical information. It will, we think, be welcomed by every surveyor and municipal engineer. It has been prepared with the special view to examination in the Engineering Section of the Incorporated Association of Municipal and County Engineers. It goes, however, considerably beyond the limits of a class-book, and is entitled to be considered a standard book of reference.

Arc Lamps, and How to Maintain Them: a Practical Handbook for the Use of Those having charge of Arc Lamps. By H. Smithson and E. R. Sharpe. London: Whittaker & Co. 1s.

The authors of this little work state in their preface that "what has long been wanted is a good plain-spoken book; not going too deeply into electrical matters, but far enough to show how Arc Lamps should be treated; how small breakdowns may be repaired, which would otherwise necessitate the employment of a skilled electrician and the consequent expense; and lastly, how the lamps may be kept in good order, so that the best light may be obtained for the least money."

As to how far the public demand for such a book may exist, the publishers are probably in the best position to judge. So far as they have gone, the authors appear to have done their work fairly well, though they seem to have omitted any reference to several arc lamps in extensive use.

NEW CATALOGUES.

The Editor will be pleased to supply copies of any catalogue noticed.

Asbestos, Lubricants, Engineers' Requisites.

The great range of manufactures generally known as "mills' furnishings," is well illustrated in the Catalogue just issued by the United Asbestos Co., Ltd., in which the whole of the branches of the Company's manufactures are brought together for the first time. The United Asbestos Co., Ltd., made their reputation in the first instance in association with Asbestos, one of the most valuable engineering accessories ever introduced. The Company claim (through amalgamation) to have been the first to engage in the European Asbestos trade—to be the foremost in adapting the mineral to the every-varying requirements of engineers. The Company hold the unique position of owning and working their own Asbestos mines in both Italy and Canada. The high qualities of their manufactures is avouched by the fact that the Company has held British Admiralty contracts for fourteen years in succession. But

the brand and trade-marks of the Company are in themselves a guarantee of quality. The Catalogue before us is noteworthy for the variety of its contents and the precision and fulness with which they are treated. These embrace Asbestos goods; rubber manufactures of every description for mechanical purposes; lubricants; boiler and pipe coverings in various forms; and engineers' sundries. Among the latter will be found many useful specialities, as well as all those ordinary stores, tools, and requisites which to the steam user are a day-to-day necessity. A special feature of the Catalogue is the very exhaustive way in which packing and jointing materials have been treated. These cover not only the Asbestos in all its forms, but rubber, gutta-percha, fibre, canvas, hemp, metallic packings, &c., &c.—thus enabling an engineer to select at will whatever special packing or jointing materials are best adapted to his particular requirements.

BOOKS RECEIVED.

The Kinetic Theory of Gases. Dr. Oskar Emil Meyer, Translated by R. E. Baynes, M.A. (Longmans and Co.) 15s.

Central Station Electricity Supply. Gay and Yeaman. (Whittaker and Co.) 10s. 6d.

Fowler's Mechanical Engineers' Pocket Book for 1900. Wm. H. Fowler. (Scientific Publishing Co.) 1s. 6d.

The Locomotive of To-day. (The Locomotive Publishing Co.)

Steam-Engine Theory and Practice. William Ripper. (Longmans, Green and Co.) 9s.

The Elements of Physics. Henry Crew, Ph.D. (Macmillan and Co.)

Britannia: the Organ of the National Unity Movement. We direct attention to an announcement on page lv of this issue (back part of the magazine).

Out of Print.—An Explanation.

The Proprietors of FEILDEN'S MAGAZINE have been receiving numerous letters from many parts of the country complaining that the writers were unable to obtain copies of this Journal, and asking to have them forwarded direct from the Publishing Offices, at the same time taking, in some instances, exception to the premiums which, owing to the encroachments on our binding reserve, we have had perforce to impose on back issues. As complaints still reach us, we append the following explanation. On communicating with Messrs. W. H. Smith & Sons, who gave us larger orders than we expected, and which were afterwards repeated, we were met with the reply we print below, which, however satisfactory to ourselves as indicating the extraordinary demand for the Magazine, we hardly expect will be equally so to those of our readers who were not fortunate enough in the first instance to secure their copies at the published price.

MESSRS. W. H. SMITH & SONS

To the PUBLISHER OF "FEILDEN'S MAGAZINE."

"*It should not be at all surprising to you to learn that so many important Bookstalls are without copies of your Magazine, as you confess your inability to supply more than one-fifth of our* REPEAT ORDER, *which was intended to supply some of the very stalls you now complain of as being without copies for sale.*

"*Every Bookstall in the country had a supply, and many Clerks sold out at once and applied for more, which we sent as long as our supplies lasted.*"

We have now adopted the obvious remedy, and are making arrangements for the augmentation of our printing and publishing resources in order to meet the increasing demand for 1900. At the same time, as the popularity of the Magazine shows a constant upward tendency we cannot absolutely guarantee back copies to anyone. Firms and individuals, therefore, desirous of securing all the issues of the Magazine for 1900, are strongly advised to send us a Postal Order for 12s. 6d., when this year's editions, including any special numbers issued, will be forwarded on publication, post free. Annual subscribers are entitled to the Art Paper editions which are superior to the ordinary copies, the engravings being magnificently printed, and the Special Plates being produced in two delicate tints. These editions make splendid binding copies for preservation. Now is an exceptionally good time for commencing your subscription, as this issue commences a new volume.

No more Art Paper Copies of the First Five Issues are available, but a few copies of one or two issues on the cheaper paper still remain, these being priced now at 2s. each. We guarantee no particular issue, however, and can, necessarily, only supply what we have as long as they last.

Numbers 4 and 5 of FEILDEN'S MAGAZINE contained, with a mass of other valuable matter, special articles on Technical Education, a Revolutionary Invention in Weaving, Steam Vehicles, Machine Tools, Acetylene Generators, Modern Appliances in Gas Manufacture, British-Chinese trade, American Locomotives in Britain, Acetylene for Motive Power, Pneumatic Tools and Appliances, Automatic Guns, &c., &c., &c., by among others, Sir Edmund Verney, Bart., Prof. Roberts Beaumont, John I. Thornycroft, F.R.S., &c., E. C. Amos, M.I.M.E., &c., Prof. Vivian B. Lewes, F.I.C., &c., G. E. Stevenson, M.I.C.E., &c., Hiram S. Maxim, Frederick Grover, A.M.I.C.E., &c.

The value and importance of the 1900 editions will be still further extended.

☞ *Subscription Form accompanies this issue.*